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Railway Mechanical Engineer

FOUNDED IN 1832

as the American Rail-Road Journal, with which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic. Name Registered, U. S. Patent Office

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SUPPLY TRADE NOTES

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OBITUARIES

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Timely MESSAGES

From the leaders of Mechanical Department Associations and Related Government Officials

FOR several years the natural forces of recovery in this country have been attempting to assert themselves. Until recently, however, they have been more or less effectively thwarted. It now appears, on the basis of developments during recent months, that we are quite definitely headed for better times.

The railroads have had a long and difficult struggle. They have cut their forces to a minimum, younger men have been almost entirely eliminated, and to a large extent training processes have been discontinued. In the effort to conserve their resources, they have failed to replace old and obsolete equipment and facilities, and maintenance has been deferred to as great an extent as possible, except where safety was concerned.

Bright Lights in Picture

There are some bright lights in the picture. In the effort to fight unfair and subsidized competition and retain business, railroad services have been greatly improved, even in these lean years. Air conditioning of passenger cars was started in the very depths of the depression and this is true, also, of the introduction of the high speed, streamline trains.

Railway equipment manufacturers were forced to close down their plants and struggle along with skeleton organizations, yet their engineering and research forces have been kept on the job, ceaselessly searching for improvements which would make it possible for the railroads to operate with greater efficiency and economy, at the same time speeding up and improving the comfort and convenience of their services. As a result, many new materials and devices and types of equipment are now available, which, when installed, should contribute to improved services and increased earnings.

The clouds seem to be breaking and the stage is now being set for a distinct forward movement. Man power to meet these new conditions is a prime essential. No steps should now be overlooked to recruit and train the men that will surely be needed within a matter of months. A few far-sighted mechanical department officers quietly took the first steps in this direction months ago. Six years of depression have seen the passing of many of the older skilled supervisors and workers. This gap must be closed up, and quickly, if the railroads are to keep pace with the demands that will surely be made upon them in the near future.

Value of Mechanical Associations

One agency of great value in coaching the officers and supervisors and in inspiring and spurring them on to greater and more effective efforts, is highly specialized group meetings and conventions. The associations of various groups of mechanical department officers and supervisors have suffered severely and have almost discontinued operations during the past few years. Based upon past performances these associations are invaluable, and yet the railroad managements have been so harassed with difficulties that in the mechanical department, at least, they have been allowed to lie more or less dormant. Interestingly enough, this is not true to the same extent of associations of other than the mechanical department. The engineering, signaling, operating and traffic organizations have functioned much more actively and aggressivley throughout most of the depression.

Can the mechanical department associations stage a real and substantial comeback? Apparently this will depend upon the small nucleus of officers and active members in each group. The possibility of reviving some of these organizations to something of their old vigor was demonstrated last fall, when four of them—in the face of lukewarm approval or even opposition of the official bodies—held short meetings and put over programs—particularly good programs under the circumstances.

Such organizations mean much to the railroads, even though their value at this time is being largely overlooked. Unofficial as they are in most cases, their functioning depends upon the interest, initiative and ability of the outstanding leaders in the different groups. Here is a positive and constructive force for improvement and betterment that should be conserved and encouraged. With better times ahead—even if farther away than now seems apparent—it is not a bit too early to start to move forward. Indeed, it appears that we have already too long delayed in getting started.

With these thoughts in mind we have invited the leaders of the various mechanical department associations to utilize our pages this month, extending greetings to their fellow members and telling something of the problems which must be tackled, and the plans that are now contemplated or in process. Then, too, we have asked for expressions from some of the government representatives who work intimately with the mechanical department officers.

These messages follow, and with them go the enthusiastic good wishes of the staff of the *Railway Mechanical Engineer* for a most happy and prosperous year to our readers throughout the world—in whatever department, or wherever they may be.

INVEST IN MAN-POWER

Now is the time to recruit promising young men

by O. A. GARBER

Chairman, Division V—Mechanical—Association of American Railroads; (Chief Mechanical Officer, Missouri Pacific Railroad)

TO Members of the Mechanical Division, Association of American Railroads: In my opinion the problem confronting us most pressingly in the immediate future is the proper selection of young men for mechanical training.

Most of the railroads, in some craft, and a few of the more fortunate railroads in all crafts, have increased the personnel to the extent that under our agreements with the shop crafts we can augment our force of apprentices.

I hope and feel that the present upturn in business is going to be such that practically all of us will be putting on a considerable number of new apprentices during the next year or so. At this time we have a large number of high-grade young men from which to choose. The selection must be intelligently supervised in order to select young men of good education, preferably graduates of high school, and boys who are mechanically inclined. Sometimes we can secure a boy who has had one or more years in a mechanical college or technical school.

After they are employed our opportunity for properly training them to make high grade mechanics, useful citizens and in many cases efficient supervisors is unlimited. The shop supervisor, the general foreman, the master mechanic or the shop superintendent should all appreciate the importance of carefully checking these young men in the early stages of their employment, and if it is found that they are lacking in desire or attentiveness, in all fairness to the young men they should be directed to other lines of endeavor. Those who do indicate an ability to learn mechanical work and are willing to study to improve themselves should be in a position to secure through you a line of educational training for apprentices which a number of roads have in effect, some with their own staffs and some with outside institutions which specialize in this work.

Any railroad will be well repaid for investing in educational training for these young men.

LOOKS FORWARD TO 1936 CONVENTION

Perplexing problems to be solved; new facilities and equipment available

by A. H. KEYS

President, International Railway General Foremen's Association; (District Master Car Builder, Baltimore & Ohio)

TO Members of the International Railway General Foremen's Association: I wish to convey to each of you my sincere good wishes for a happy and prosperous New Year. The International Railway General Foremen's Association was formed on September 7, 1905, a little more than thirty years ago, by a small group of master mechanics, superintendents of shops and general foremen. These men felt the need of an international organization, made up of railroad general foremen, both in the car and locomotive departments, who could attend annual meetings or conventions to discuss the various improvements and to learn from each other the many short cuts that can be effected in shop operations.

The annual meetings which have been held subsequent to that time have, I am sure, proved of great mutual benefit to the members of our association, as well as

to the railroads we represent. During the trying period through which the railroads have passed in the last five years, it has been impossible for our organization to meet in convention, although there have been regular annual meetings of officers and committeemen. At our last meeting in Chicago during September, the attendance was gratifying and the committee reports and the discussions were most interesting and instructive. I am sure all of those who attended took home with them many new ideas that will react for the mutual benefit of both the railroads and their employees, in the matter of increased efficiency and better maintenance in equipment.

The present business outlook for industry indicates substantial gains, and we all are hopeful that carloadings on the railroads will continue to rise; this in turn will create a demand for additional car and locomotive equipment. We are also hopeful that it will be possible to meet in convention in 1936, so that our membership throughout the country can again come together and thrash out the many perplexing problems that have confronted them since the last convention, view exhibits showing the improved locomotive and car appurtenances which have been developed since that time, and get first-hand knowledge from the exhibitors as to their proper maintenance. When they return to their respective shops they can then pass on this knowledge, to the mutual advantage of both the members, their subordinates and the railroads which they represent.

URGES YOUNGER MEMBERS TO PICK UP REINS AND CARRY ON

"We cannot stand still; we must push on to greater achievements"

by W. H. CLEGG

President, Air Brake Association; (Chief Inspector, Air Brakes and Car Heating Equipment, Canadian National Railways)

TO Members of the Air Brake Association: In sending my greetings to you at this time it is with the hope that we may anticipate a personal exchange of greetings in the very near future. Our association, for obvious reasons, has been quite inactive since our last meeting in Chicago in 1930. Up to that time it played a very important role in the country's railway transportation problems. Its activity also served admirably as an educational and highly specialized medium to the Air Brake Art.

The railways were never in greater need of united action by our members concerning the fundamentals involved in the study of valvular and foundation brake developments, the handling of such intricate and delicate mechanisms, together with the high standard of accuracy in the maintenance of such equipments to meet the problems of braking requirements for lightweight heavy-capacity freight cars, controlling the long heavy freight trains, and stopping the high-speed passenger trains of today. Great strides have been made during recent years in the development of air brake designs of one kind and another, at very great cost, to meet the operating conditions demanded by such an extensive and populous country. The railways have, by test and trial, also spent large sums of money in the hope of finding a satisfactory answer to such problems.

It is the objective of the Air Brake Association, by discussion in convention, by the work of its various committees and through co-operative effort of its members, to diffuse the much needed information concerning the endless developments in brake equipment—its new functions, care, management and requirements—to meet the ever increasing demand for greater knowledge on the part of those directly concerned with its proper functioning, maintenance and operation—all of which have become so much more exacting and important in every phase and detail.

During these recent years many of our valued members have retired from active service, others have passed on, and the younger men in the field must pick up the reins dropped by their predecessors and carry on. We cannot stand still; we must push on to greater achievements in that spirit of zeal, courage, determination and tenacity of purpose which is so characteristic of the Air Brake Association.

EFFICIENT LOW-COST LOCOMOTIVE OPERATION

by

A. T. PFEIFFER

President, Traveling Engineer's Association;
(Road Foreman of Engines, New York Central)

Fast schedules must be maintained in both freight and passenger service— Fuel must be saved

IT is with great pleasure that I extend my greetings for a happy and prosperous New Year to the members of the Traveling Engineers' Association, with the hope and confident expectation that it will continue, as it has in the past, its efforts to improve locomotive service on American railroads.

It is doubtful if any businesses have been so hard hit in the last five years as our railroads. Unlike some of the competing types of transportation, they have not been subsidized with governmental aid.

The depression has prevented the Traveling Engineers' Association from holding its annual conventions to discuss problems of more efficient and more effective locomotive operation. Through the persistent efforts of our secretary, W. O. Thompson, meetings of the executive committee were held each year up to 1935, when we held our recent convention. The Association has been held intact and stands ready to do everything in its power to assist in improving locomotive conditions in the future.

It is of vital importance that fast schedules in both passenger and freight service be maintained, in order to compete effectively with other types of transportation, including buses, trucks and air lines. These have made inroads into the business of the railroads, particularly since only recently has the public taken any steps to place them under adequate regulation.

The task of our members is to bring about more efficient locomotive operation and to reduce the fuel costs. We are looking forward to a large attendance at our 1936 convention, in order that we may prepare more effectively to solve some of the pressing problems in locomotive operation which now confront us. Surely our membership, with railroad executives, officers, supervisors and employees in all capacities, can be an effective force for betterment.

SET PACE FOR OTHERS TO FOLLOW

Boiler makers out to make a real record for their association

by O. H. KURLFINKE

President, Master Boiler Makers' Association;
(Boiler Engineer, Southern Pacific Railroad)

TO members of the Master Boiler Makers' Association: I thank the *Railway Mechanical Engineer* for affording me this opportunity to extend to each of you the season's greetings and to wish you a prosperous New Year.

I also take this occasion to inform you that, in collaboration with the executive board through its chairman and the valued counsel of the secretary, plans are being formed which we believe will make our 1936 business meeting the most interesting and successful one of its kind the members will have the opportunity to attend for some time.

Our first obligation is to insure that the Master Boiler Makers' Association will always be so organized that it will be prepared to function in a manner that will place and keep it at the top of the list of independent organizations.

We are all aware of the reversals the railroad industry received during the past several years and know that upon their return to normalcy they will make changes which will alter the methods of conducting their affairs in order to eliminate waste wherever it is found to exist. Therefore, it is equally important for us not only to have as our object the exchanging of views among ourselves so that we may profit by the experience of other members, but also to have as our object the spirit of broadcasting in our proceedings a definite stand that our members as an association are united and will not be afraid officially to recommend sound and practical methods as standard practice so the industries, and especially our employers, will have the benefit of our general interchange of views.

Your active officers will have presented at the next meeting a series of topics which will command your attention. The particular topic at that time will be on "Law." This will include proposed changes to our Constitution and By-Laws which were prepared with a view to setting up the organiation on lines which will expedite the handling of its affairs and also effect economy where possible to do so.

Considerable thought and effort have been expended to have a method of procedure which will bring out definite conclusions in the discussion of topics covering the best practices and these will be presented to you for your approval. I urgently request that all of you make it a New Year's resolution to be on hand at the 1936 meeting, and take personal action and express your views on these proposed changes and to support the efforts your officers have conscientiously made to make your association foremost and at all times the one that will set the pace for others to follow.

HOW TO REDUCE THE FUEL BILL

Program of Fuel Association adapted to meet changing operating conditions

by C. I. EVANS
President, International Railway Fuel Association; (Chief Fuel Supervisor, Missouri-Kansas-Texas Railroad)

TO the Officers and Members of the International Railway Fuel Association: Greetings. The International Railway Fuel Association enters its twenty-seventh year of existence with better prospects and greater responsibilities than for the past five years.

From the best information obtainable it is believed that business for the railroads will be better during 1936 than 1935, but the conditions of operation are more difficult. The time schedules in both passenger and freight service have been shortened, necessitating higher speeds, which require that more fuel be used and lighter trains be handled thus increasing the cost of transportation.

Passenger rates and the rates on many commodities are lower, which makes it necessary to handle more business in order to take in as much money.

The price of fuel is higher. Our problem then, is how to reduce the fuel bill with more exacting conditions of service, with faster time and lighter trains, made necessary by the competition of other methods of transportation.

All employees should be and I believe are, vitally interested in seeing that the net revenue of their particular railroads is as great as possible and every employee in the mechanical and transportation departments, from the call boy to the general manager, can help increase the net by giving a little more thought to his work, and doing his job, whatever it may be, a little better than he has ever done it before.

Our program of subjects for the consideration of the association this year is similar to former years, but arranged in light of the changed operating conditions.

The chairmen of the committees on these subjects, and the individual members of these committees, are all experienced and outstanding in their line of work and were chosen from all parts of the country so that the best information might be obtained to enable the chairmen to compile the contributions into the most valuable reports possible for the benefit of all railroads, including Canada and Mexico.

With more business and more thought put into action by those who are responsible for getting the best results from the use of fuel, combined with the close cooperation of all other employees, I feel confident that by December 31, 1936, our problem will be solved satisfactorily.

PROBLEMS HAVE GROWN AND MULTIPLIED

One idea from convention may offset the cost of a dozen years' attendance

by H. L. TAYLOR

President, American Railway Tool Foremen's Association; (Baltimore & Ohio Railroad)

TO the Members of the American Railway Tool Room Foremen's Association: It is with great pleasure that I take advantage of the opportunity offered to me through the courtesy of the *Railway Mechanical Engineer* to extend greetings to our members.

It would, of course, be much more pleasant to extend the hand in hearty greetings, but due to forces which were beyond our control it has not been possible to do this.

It would seem from all signs that the coming year will lift us from the slough of depression and if the portents are correct then we should be able to assemble once more in the Spring. We are preparing to start preparations to assure as large attendance as possible and earnestly request your presence.

Since our last meeting our problems have grown and multiplied, and there is much work to do. Streamlined locomotives, Diesel locomotives, new designs and materials, all kinds call for new designs of tools and tools of better material. Problems galore have crept in with the desire of the management for more economical operation. New designs in pneumatic hammers and drills, and in some cases new inventions have been devised which should be discussed for the benefit of our members. All of these developments, of course, are shown and discussed in the various trade papers, which are invaluable in keeping us in contact with the development of new ideas and refinements in the old, but the application of these to our own problems are our own province and herein lies the value of our Association.

The discussions in the meetings, the "swapping" of ideas and the solutions of difficulites are of inestimable value to our companies and one item carried back will frequently more than compensate for the cost of a dozen years of attendance. We will do our part and sincerely request you to do yours to bring this to the attention of your supervisors so that we will have a large attendance when we assemble. We know you will be enthusiastic when you get there, so let's all *come!*

READY TO GO AHEAD

Great need for special educational effort at this time

by K. F. NYSTROM

President, Car Department Officers' Association; (Superintendent Car Department, C. M. St. P. & P.)

OFFICERS and members of the Car Department Officers' Association have conscientiously complied with the wishes of the Association of American Railroads and have not held any conventions or carried on any activities which would involve expense during the time of depression. We will continue to observe these wishes, hoping for a definite expression from the Association to indicate whether or not the various mechanical associations are desirable as an educational factor among mechanical supervisors.

The Car Department Officers' Association—formerly the Railway Car Department Officers' Association and the Southwestern Master Car Builders and Supervisors' Association, which were amalgamated in 1928—has a long and honorable record of serving as an educational institution. Its activities consisted of having a number of committees

study car department problems. At the annual conventions, which had a large attendance, valuable papers were presented, which were enthusiastically discussed—all pertaining to car department matters, with particular emphasis on interchange problems. In addition, from the experience of the members attending from various parts of the continent, recommendations were made to the old Master Car Builders' Association and later to the American Railway Association to change or clarify interchange rules. The recommendations thus submitted were in the majority of cases favorably acted upon, since they came from men who faced the actual problems.

By meeting members from other railroads at the conventions, acquaintances and friendships were made and understandings developed which, in addition to the educational value, made it easier to handle the interchange of cars among the railroads. Unquestionably the exchange of ideas by members at the conventions, or as a result of acquaintances formed at such conventions, effecting shop practices and methods of handling of work, have been of untold benefit to railroads represented in this Association. The spirit and enthusiasm manifested at these conventions could only be interpreted to mean an expression of the desire on the part of those attending fully to take advantage of the opportunity to improve their knowledge.

The future of the Car Department Officers' Association depends on two things: First, will it have the full sanction of the Association of American Railroads, and second, can it prove its usefulness? During the depression many supervisors were laid off or demoted, many of whom will not be available when business improves, and their knowledge and experience is thus lost to us. Unfortunately very few men have been trained and educated to take their places. I feel that if the Car Department Officers' Association is again permitted to function as it did prior to the depression that the railroads will be repaid many fold by reason of furthering the education of its members and it will also be helpful to the younger men starting their career in the supervisory field.

May I express my humble appreciation for the confidence, loyalty and support given me by members of our Association, and extend to all hearty greetings.

RAILROAD MECHANICAL ENGINEERING

Specialized upon by independent group of interested engineers

by **GEORGE W. RINK**

Chairman, Railroad Division American Society of Mechanical Engineers
(Mech. Eng., Reading Company)

As chairman of the Railroad Division I extend greetings to all engineers engaged in furthering the interest of the railroads and welcome them to the meetings of the American Society of Mechanical Engineers.

The membership of the Railroad Division of the A.S.M.E. is made up of representative mechanical engineers from the railroads, the railway supply industry and our engineering colleges—men who are engaged in the study and perfection of materials, devices and facilities required for use on the railroads, as well as in the development of new types of motive power and equipment to meet the demands of the public and in the interest of safety and economy of operation.

The Railroad Division is active in encouraging study and development of the underlying fundamental principles of mechanical engineering applicable to railway use. Its endeavor is to be co-operative with the activities of the Association of American Railroads.

Typical of the activities of the Railroad Division is its participation in the recent annual meeting of the American Society of Mechanical Engineers. The Railroad Division held three sessions and due to the activity of its committee on meetings and papers, of which W. H. Winterrowd is chairman, a number of papers were presented which involved considerable research on the part of the authors. These papers had reference to various

problems in connection with the action of locomotives and cars while in motion. The committee on survey also presented a paper on the progress made in railroad mechanical engineering during 1935.

L. W. Wallace, in charge of research work for the American Association of Railroads, addressed the members and emphasized the importance of research; he paid a glowing tribute to the railway supply companies, which at considerable expense are working on the problems now confronting the railroads. He also commented on the large expense borne by the railroads and air brake companies in conducting the air brake tests on the Southern Pacific, which resulted in the adoption of the new "AB" brake.

The committees are composed of representative men in the field of engineering. In addition to the annual meeting, which is always held in New York City, the Railroad Division of the American Society of Mechanical Engineers will hold sessions or co-operate in meetings in 1936 at Dallas, Texas, San Francisco, California, and Buffalo, New York.

A CRUSADE AGAINST ACCIDENTS

by C. F. LARSON

Chairman, Safety Section, Association of American Railroads; (Superintendent Safety, Missouri Pacific Lines)

"Safety work is the noblest of all purposes because it embodies the highest ideal of humanity"

THERE is a growing sensitivity all over the world to consider human life worth saving. Any plan for human betterment cannot overlook the protection of the individual against accidents. The ultimate aim of all industry, science and government is for a better life and better living conditions. The better life towards which we are striving must include opportunity for mental and spiritual development, as well as material comforts.

The safety movement had its origin on the American railroads, spreading from these into every industry, and into public life—on the streets and highways and in the schools—wherever hazards of accidents exist. But, nowhere has the effect of the movement been so marked as upon the railroads where it is highly organized. Every department and every classification of labor has been touched by the teachings of safety, and every department has a reflected glory to its credit.

Because of the seriousness of train service accidents, train and enginemen are frequently more gravely injured and incapacitated for longer periods than men in some other classification, since they must be 100 per cent whole when going about their tasks. The great improvement—amazing in its achievement—is one of the many happy results of the safety programs. Once, (long ago) antagonistic and suspicious of the movement, the train service employees are now the most enthusiastic. Maintenance of way employees too, have responded nobly and have much to their credit in the summary of the happy achievements of a quarter of a century.

The maintenance of equipment forces have a very large percentage to their credit in reducing casualties. This class of labor has probably an advantage over some others. Usually, and mostly, mechanical forces are recruited from boys of at least grammar school education and many are high school graduates. As a rule they are ambitious to advance to higher places in the ranks, often going from shop apprenticeships to technical schools to better prepare and fit themselves for advancement. Men in these trades, because of the attainments mentioned, are more susceptible to the teaching of safety, being appreciative of its value.

Then, too, men in the trades (mechanical) have the advantage of closer and more constant supervision than employees out on the line of railroad. Intelligent supervision is, after all the answer to the safety question. Experience has demonstrated that successful accident prevention

work among employees depends entirely upon the amount of interest and leadership accorded it and the support which is obtained from officers and supervisors, and receptivity and responsiveness of those to whom the safety message is given. A supervisor or foreman is not just a "boss." He is a leader, teacher or instructor and must have the confidence and good-will of the men entrusted to his supervision.

It is, of course, the desire of management that employees be saved from injury and time and money is spent in developing the best means or methods by which this can be attained. On well regulated properties these thought-out methods are promulgated in the way of safety rules, regulations and instructions. The supervisor is clothed with the responsibility of presenting these lessons to the men over whom they exercise authority. The best teacher is the one who knows all that he can learn about the details of his assignment and then has the ability to stimulate interest in the employees. The most important thing, then, in a railroad career is to learn the art of dealing with fellow-employees in such a way as to win their confidence and to be able to direct them in a proper way.

Accident prevention or the problem of safety is primarily an educational problem; it must be continuous, constructive and interesting. Each worker is safe in proportion as he understands the hazards of the job and he can understand only in proportion to his safety education. Example has much to do in this educational process. Officers and supervisors alike must, by their example, set the pace. Shakespeare said—"Grow great by your example," and another writer is quoted "Instead of keeping our eyes ever on others, looking for faults and mistakes, we are to look to our own example, lest something we do may hurt their lives, or cause them to do wrong."

Employees who are indifferent to the teachings and instructions offered and violate rules, are simply tampering with their consciences, excusing wrong, making it a slight thing; arguing with one's self that the act is not so bad after all. Some will say as an excuse, "I did not know and you can't hold me responsible for what I did not know." Yet is this not one of the most serious fallacies with which man can beguile himself? Man should know everything that he can know, particularly that which is socially important for him to know. We have principles of law that ignorance excuses no one. Ignorance of the laws of nature excuses no one. Ignorance of the things that are dangerous with which man operates excuses no one. Ignorance, inattention and willfulness cause the great troubles in this world. These attitudes can be changed by a properly directed educational program, emphasizing the fact that serious injuries are social problems, many of them with aspects entirely outside the scope of compensation acts or industrial welfare departments.

Sometimes only the community can attempt to deal with juvenile delinquency which results from a diminished income or from loss of discipline in a home headed by a cripple. An altered standard of living may be responsible for mental breaks and reduced ambitions. Casualty hazards are simply one group of important problems, and as such cannot be divorced from any program of industrial and economic planning. Safety work is the noblest of all purposes because it embodies the highest ideal of humanity—to save human life and limb and thereby promote happiness in the lives of workers. In this great cause,—a crusade against accidents—officers, supervisors and employees will be more effective if they are moved by the spirit of useful service.

SAFETY OF HIGH SPEED FREIGHT TRAIN OPERATION

Necessity for improvement in air brakes, draft gear and truck

by W. J. PATTERSON

Director, Bureau of Safety, Interstate Commerce Commission

ONE of the outstanding features of present-day railroad operation is increased speed. The introduction into service of light-weight, high-speed, streamlined trains, with their tremendous popular appeal, has been accompanied by a general stepping-up of passenger train schedules, and, perhaps of even greater importance, by faster freight

(Continued at top of next page)

train operation. To insure safety of operation of long or heavy freight trains at the relatively high rates of speed which are now authorized on many railroads, high standards in the design, construction and maintenance of mechanical equipment are required.

Efficient brakes are of primary importance. High-speed operation is safe only when brake equipment is adequate properly to control trains under all conditions. As a result of cooperative action by the Bureau of Safety and the Mechanical Division of the Association of American Railroads, rules for maintenance of power brake equipment were revised in 1926, and higher standards of maintenance which were set up by these revised rules have resulted in substantial improvement in the condition of power brake equipment in general service. Furthermore, as a result of extensive tests, the specifications for brake equipment for freight cars were revised to establish a new standard, effective September 1, 1933, and interchange rules have been revised to require not only that all new cars must be equipped with the new standard brake equipment but also that brake equipment in service must be made to conform to the improved standard progressively on an annual basis, this program to be completed by 1945.

Car trucks and draft gears, in addition to brakes, involve important safety considerations. Arch bar trucks have long since become obsolete and slated for removal from service. Experience has demonstrated that trucks of this design cannot be relied upon to withstand the stresses incident to present axle loads and train speeds. No practicable system of inspection of trucks of this design can insure safety. Under present rules, arch bar trucks will be prohibited in interchange effective January 1, 1938. Current reports of progress being made in reducing the number of cars in service which are equipped with arch bar trucks point to the need for greater attention to this important matter.

The adoption in 1931 of specifications for draft gears for freight service marks an important step in the progressive and systematic improvement in this equipment. The requirement that draft gears approved under these specifications must be applied to new cars has been in effect only two years, and only since January 1, 1935, for new draft gears applied to any cars; thus far approximately 84,000 cars have been so equipped. For the purpose of expediting removal from service of the most inefficient gears a number of such gears have been designated as obsolete, and only scrap value is allowed for replacements or parts. There are some 2,000,000 freight cars in service equipped with draft gears other than the approved standard, and for the purpose of improving the condition of these draft gears until they can be replaced by standard gears the present recommended practice rules provide that when cars are on repair tracks for periodic air brake attention by owners, defective parts of draft gears will be renewed and if the draft gear is defective or the total slack exceeds 1½ inches the draft gear will be removed for examination. Excessive free slack in draft gears is a hazard to train operation, and the present rules which are designed to effect a prompt and general improvement in this respect should be rigidly observed.

Brakes, draft gears and car trucks, adequate in design and maintained in efficient condition, are essential to the safe operation of modern freight trains. Due recognition should be accorded to mechanical department officials and employees for the constructive action which has been taken by them to provide these essentials, and the measures which have thus been inaugurated should be vigorously supported and pressed to a conclusion.

COMMENDS MECHANICAL DEPARTMENT FORCES

by JOHN M. HALL

Chief Inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission

Contemplated changes in design should be carefully checked with Bureau

DURING the past five years the railroad mechanical forces have been subjected to economic pressure unprecedented in the history of American railroads. Financial conditions have resulted in drastic cuts in mechanical department appropriations, in many cases to a point where, even after consideration of every possible economy, the problem of proper maintenance

of equipment appeared almost without solution. Yet the mechanical men have carried on and results show how well they have succeeded.

We of the Bureau of Locomotive Inspection appreciate the helpful cooperation from mechanical officials and employees, also many operating officers, which has generally been encountered, for we are not unmindful that, without such cooperation, we could not have achieved the results obtained, and I am quite sure that this cooperation is a reflection of our efforts to perform our duty in the enforcement of the law and rules in an intelligent, reasonable and practical manner.

The purpose of the Locomotive Inspection Act as expressed in the title is "* * * to promote the safety of employees and travelers upon railroads * * *," and reference to the large decrease in the number of casualties since its enactment will show how well the law has fulfilled its purpose. The rules formulated under the law are based upon recognized minimum standards of safe and proper maintenance. Were it not for the existence of the law and rules it is quite probable during the past several years that additional reductions in mechanical department appropriations would have been made with consequent telling effect on the condition of locomotives and the record of casualties. Success in enforcement of any law is dependent to some extent upon the recognized need for the law and benefits to be obtained from compliance with its requirements.

Better maintenance of locomotives, with resulting decrease in number of accidents and economies in operating costs resulting from this improvement in condition of power are conclusive evidence of the necessity for this law and the success thus far attained in its enforcement.

One feature upon which I may comment is a tendency to make certain changes in the development of the locomotive which do not conform to present requirements and then, on the pretext that these changes were not contemplated at the time the rules were approved and present design is such that the requirements cannot be met, ask that exceptions be made. Some instances of this nature have occurred in the past in which it has subsequently been found that there was no necessity for the claimed exemptions. When changes in design are contemplated we would emphasize the advisability of examination of pertinent rules and, in case of apparent conflict with or restriction of the proposed design, suggest that the question be discussed with this bureau in order that violations may be avoided. It is desirable that proper consideration be given to new designs that they may comply with the requirements rather than to proceed with the changes and then attempt to stretch the structures of the law to cover them.

When changes in or new rules are thought desirable, the modus operandi is plainly set out in Section 5 of the law. However, it is pointed out that such changes are not effective until they have been approved by the Interstate Commerce Commission.

MECHANICAL OFFICERS CHALLENGED

Success in competing with other types of carriers will depend on proper equipment

by **OTTO S. BEYER**

Director, Section of Labor Relations, Federal Co-ordinator of Transportation

JUST as in the days of Stephenson, motive power and rolling stock are still the chief physical instruments of railroad transportation. But the railroads, because of new ways of utilizing power for the movement of vehicles, no longer enjoy the monopoly of transportation they once did. The challenge to the railroads because of these developments is therefore chiefly a challenge to those to whom the future of the mechanical equipment is entrusted. If they are successful in designing and building equipment which will permit of operating short, light trains and furnishing frequent, rapid service, the railroads stand to hold

their own in the struggle which now confronts them.

In the circumstances, it behooves all who have to do with the mobile plant of our railroads to visualize the needs of the time and, as a first step, agree that co-ordinated research in the field of railroad equipment engineering and utilization is indispensable to genuine progress in the rehabilitation of the railroad industry.

I for one would like to see the mechanical personnel of our railroads—officers, technical experts and mechanics—assert themselves in no unmistakable terms on this matter. The time is ripe!

SHORT HAUL PASSENGER PROBLEM

Mechanical department must furnish equipment to provide cheap, convenient, fast and comfortable service

by JOHN C. EMERY

Director, Passenger and Merchandise Service, Section of Transportation Service, Federal Co-ordinator of Transportation

THERE are few railroad problems more perplexing than that of how to develop short-haul passenger traffic. Primarily, of course, this is a matter for the traffic department to worry about, but it concerns mechanical department officers also because the answer may have to come from them.

Some railroad men are convinced that the local passenger business is "gone for good." Granting that the situation is not encouraging, the fact remains that local passenger traffic must not be "gone for good" from the railways. It is a vital necessity if the railroads are to make a comeback as passenger carriers.

The elements of the short-haul passenger problems can be simply stated. This business is moving now largely in private automobiles, and the automobile is chosen because it is cheap, it is convenient, it is fast, and it is comfortable. These are the service features which the railroads must offer if they want the business. What type of vehicle can the railroads employ to fill the bill?

Cheapness means a low rate of fare, so the railroad vehicle must be economical in operating cost. Convenience means frequent service even over light-traffic lines, so the railroad vehicle must be small enough to permit the operation of several schedules a day at low cost. Speed means rapid acceleration as well as ability to maintain a fast pace, so the railroad vehicle must have adequate power, but not so much as to interfere with economy. Comfort means easy riding, so the railroad vehicle must be designed to roll as smoothly and seat the passengers as comfortably as a limited train.

Those are the specifications, and they indicate at a glance the kind of vehicle which will embody them. The highway motor coach comes close to matching the specifications, but so much progress has been made lately in the design of light rail units that there is great hope for these.

Mechanical department officers can render an invaluable service to the railways by giving their full support to the further development and refinement of the light rail passenger car. The car that will help solve the short-haul passenger problem will pay handsome dividends to the railways.

Steam Rate and Indicated Horsepower of Locomotives[1]

THE overall efficiency of a locomotive may be divided into three parts: The engine or cylinder efficiency, the boiler-combustion efficiency, and the machine efficiency. A measure of the cylinder efficiency is the steam rate, or steam consumption per indicated horsepower-hour. In the past this has been determined by measuring the indicated horsepower and the steam to the engines, and dividing the second by the first. It is somewhat difficult, on a road test, to determine these values accurately. The indicated horsepower can be calculated when the mean effective pressure in the cylinders and the speed are known. The mean effective pressure in the cylinders is found by means of an indicator. The accuracy of the indicator depends upon the accuracy of the reducing motion from the crosshead to the indicator drum, the pencil motion on the indicator, the spring, and the area of the piston. With careful workmanship and calibration these errors are fairly small. It is more difficult, particularly at high speeds, to guard against errors due to inertia of the moving parts and to vibration of the apparatus.

Having obtained the mean effective pressure it is necessary to know the speed in order to calculate the indicated horsepower. A speed indicator is again a source of error, and if speeds are obtained by taking the time between mileposts the speed at the time the indicator card is taken may differ from the average between mileposts.

The next step in the calculation of the steam rate is to measure the steam to the engines. This is usually done by measuring the water fed to the boiler from the tender tank and subtracting the steam to the auxiliaries such as the air compressor, boiler feed pump, stoker, steam used for heating the train or for other train services, and steam wasted from the safety valve, injector overflow and blower. Errors arise, of course, in the measurement or calculation of each of these quantities.

Since the accurate measurement of the steam rate depends upon the accurate measurement of the mean effective pressure, speed, boiler evaporation, steam to auxiliaries, and steam wasted, it can readily be seen that the correct determination of the steam rate on a road test, using the test procedure outlined, is difficult. The suggestion has been made[3] that the steam rate be determined by means of the observation of the difference in heat content of the steam in the steam pipe and the exhaust. It is the purpose of this paper to show that, with reasonable precautions, this can be done on most locomotives with good accuracy and far less trouble than by using the indicator.

Theory of Measurement

The first law of thermodynamics states that "heat and mechanical energy are interconvertible and can neither be created nor destroyed." For steady-flow conditions, such as are obtained with an engine, it follows that "For any prime mover operating under these conditions the

By Arthur Williams[2]

A simple method of determining the steam rate by measurement of heat drop without taking indicator cards—Horsepower calculated by using exhaust nozzle as a flowmeter

energy delivered by this apparatus in any unit of time is equal to the difference of the heat contents at entrance and exit from the apparatus, for the entire amount of working substance flowing in this unit of time, minus the radiation and conduction losses from the apparatus."[4]

With superheated steam, if the temperature and pressure are known, the heat content can be obtained from steam tables. With saturated steam it is necessary to know the percentage of moisture. To measure the temperature of the exhaust steam from locomotive cylinders, when it is superheated, is simple. To measure the amount of moisture in the exhaust steam accurately, when it is saturated, is difficult, if not impossible. Accordingly, the method described is limited to those cases where there is superheat in the exhaust steam. Since most locomotives in main-line service have some superheat in their exhaust, this limitation is not very important. It must, however always be borne in mind.

Knowing the temperature and pressure of the admitted steam and the exhaust steam, the two heat contents can be obtained from steam tables. The difference between the two gives the heat drop in B.t.u. per pound of steam. This heat drop is equal to the work done in the cylinders per pound of steam, plus the heat lost through radiation. The radiation loss is relatively small, and, if desired, can be allowed for. One horsepower-hour is equal to 2,545 B.t.u. Dividing 2,545 by the heat drop per pound of steam will give directly the pounds of steam per indicated horsepower hour. It makes no difference what processes are taking place in the cylinder, whether adiabatic, isothermal, or, as is actually the case, a turbulent process which does not follow any definite law. In the extreme case, where steam is leaking by the piston, with no work being done, the heat content would be the same in the steam pipe and in the exhaust, with due allowance for radiation. This case is ths same as that of the well-known throttling calorimeter.

Value of Method for Locomotive Tests

Since it is only necessary to measure the temperature and pressure in the steam pipe and in the exhaust from the cylinders, the test apparatus is relatively simple. It is possible for one man in the cab to take all necessary readings. This may be contrasted with the test apparatus and test crew necessary for determining the steam rate by using indicators.

It is obvious that where a complete test by taking indi-

[1] Abstract of a paper contributed by the Railroad Division and presented at the annual meeting of the American Society of Mechanical Engineers, December 3, 1935.

[2] Research engineer, the Superheater Company.

[3] "Some Experimental Results From a Three-Cylinder Compound Locomotive," by Lawford H. Fry, Proceedings, Institution of Mechanical Engineers, 1927, vol. 2, p. 923.

[4] "Heat-Power Engineering," by Barnard, Ellenwood and Hirshfeld.

cator cards would not be justified, a test using the heat-drop method can be run with a low expenditure, and the various design features which influence cylinder performance can be studied as often as desired.

The following design features are commonly in question:

(1) Boiler pressure, since it controls the pressure in the steam pipe.
(2) Throttle and dry pipe. The pressure drop through these affects the pressure in the steam pipe.
(3) Steam temperature in the steam pipe, and superheater design.
(4) Size and design of valves and cylinders.
(5) Valve setting.
(6) Exhaust nozzle, both size and shape.

The necessary readings for obtaining the steam rate can be taken at frequent intervals, so that a complete picture is easily obtained of the locomotive performance at various speeds and rates of working. Even when tests are being made on the combustion efficiency of, and heat transfer in, the boiler, it is desirable to measure the steam rate and cylinder efficiency, so that the results may be more closely analyzed.

Methods of Measurement and Sources of Error

The instruments used in measuring temperature and pressure should be as accurate as possible and suitable for use in road tests on locomotives. In order to obtain a better understanding of the relation between errors and accuracy, Fig. 1 has been prepared. In this figure the four curves show the effect of errors in measure-

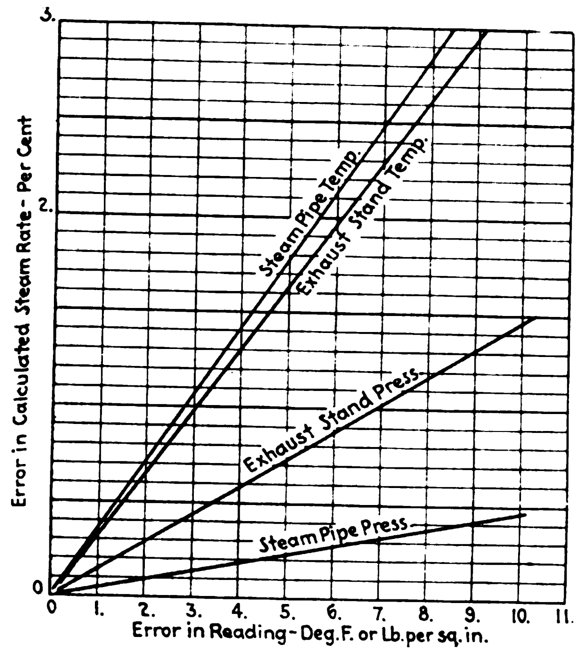


Fig. 1—Effect of errors in readings on calculated steam rate

ment of the steam-pipe temperature, steam-pipe pressure, exhaust-steam temperature, and exhaust-steam pressure, on the steam rate. An error of 2 lb. per sq. in. in measuring the steam-pipe pressure will cause an error of 0.1 per cent in the calculated steam rate. An error of 1 lb. per sq. in. in the measurement of the exhaust pressure will cause an error of 0.14 per cent in the steam rate. To measure the steam-pipe pressure to within 2 lb. per sq. in. and the exhaust pressure to within 1 lb. per sq. in. calls for only reasonably accurate test gauges. It may be necessary to make a correction for the hydrostatic head, due to the water in the pipe connecting the pressure gauge and the point where it is tapped into the steam pipe or exhaust pipe.

Measurement of steam-pipe and exhaust-steam temperatures calls for more careful consideration. If they can be measured with a maximum error in each of 1 deg. F. the resulting error in the steam rate will be 0.68 per cent. If measured with a maximum error in each of 2 deg. F. the error in the steam rate will be 1.35 per cent. Adding to these figures the errors due to steam-pressure measurements gives a total error of 0.92 per cent if temperatures are measured to within 1 deg. F. and 1.59 per cent if measured to within 2 deg. F.

The apparatus described has been used with good results. It is not meant to infer, however, that this is the only apparatus suitable for measuring temperatures to within 1 or 2 deg. F. Other means will be mentioned.

Temperatures are measured with thermocouples constructed as shown in Fig. 2. Wires used are iron and constantan, purchased in lengths. Samples of each

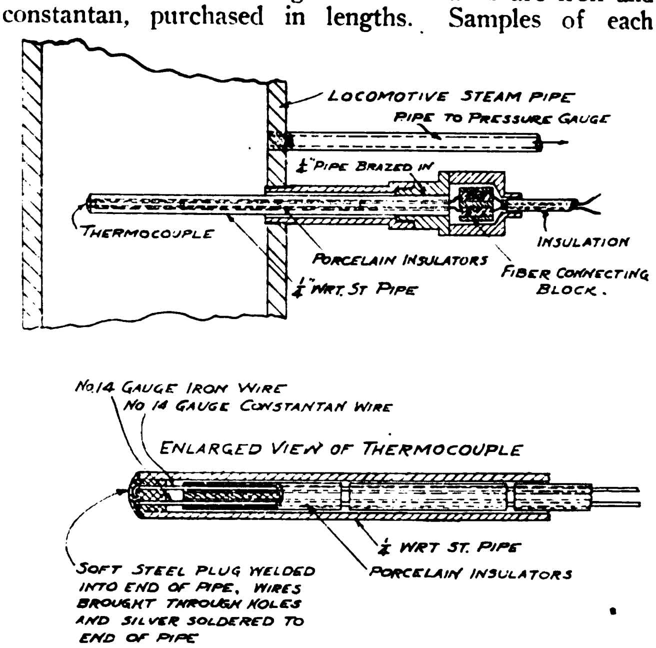


Fig. 2—Steam-pipe thermocouple and pressure-gage connection

length are calibrated, with reference to a thermometer certificated by the Bureau of Standards. The wires are led through porcelain insulators to a steel plug welded in the end of a piece of ¼-in. pipe. The wires are brought through small holes drilled in the steel plug, bent over, and, the ends covered with silver solder. This gives a thermocouple which is tight against steam pressure and will follow any change in temperature rapidly. The thermocouple is screwed into a socket which, in turn, is screwed into the steam pipe. This gives a steam space surrounding the thermocouple all the way up to the thermocouple head, which serves to minimize any errors due to conduction along the thermocouple pipe. The steam pipe thermocouple illustrated in Fig 2, is screwed into the steam pipe in any convenient place.

The exhaust-steam temperature is measured, not in the exhaust passage, but in the exhaust stand. It has been the common practice in the past to measure the exhaust-steam temperature in the exhaust passage close to the steam chest. This has been standard practice on the Pennsylvania in the tests at Altoona on the locomotive test plant. It is stated in several of the road's publication's that the exhaust-steam temperature measurements are believed to be higher than the true temperatures. The reason given is as follows:

During admission of the steam into the cylinder, heat is transferred from the steam to the cylinder walls and head. As the steam expands and becomes cooler this heat transfer stops and then reverses, so that during the exhaust stroke heat is being transferred from the cylinder to the exhaust steam. After release, when the pressure in the cylinder is higher than the average exhaust pressure, there occurs a sudden rush of steam, which by reason of its high velocity does not have time to absorb very much heat from the cylinder walls. As the piston moves on the exhaust stroke the steam, which is now moving more slowly, is heated up by the cylinder walls, with a rise in temperature.

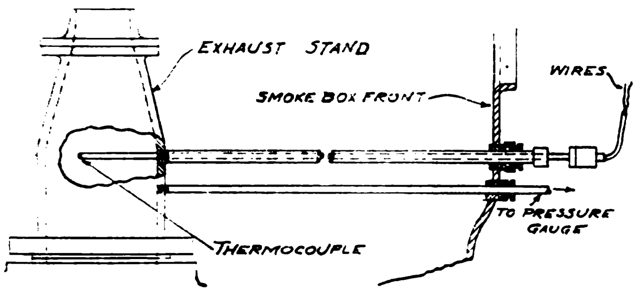


Fig. 3—Exhaust-stand thermocouple and pressure-gage connection

It is stated that the investigators believe the sudden rush of relatively cool steam at release does not register properly on the thermometer in the exhaust passage and that this thermometer is influenced more by the slow-velocity high-temperature steam during the exhaust stroke.

In measuring any fluctuating steam temperature it is desirable to provide for as much mixing of the steam as possible. Accordingly, the exhaust-steam thermocouple is located in the exhaust stand so that the steam passes through a chamber of some volume and with several bends before the temperature is measured. Also a thermocouple applied in one side of the exhaust stand will measure the temperature of the exhaust from both ends of one side of the engine, and the thermocouples applied in both sides of the exhaust stand will measure the exhaust-steam temperatures from all four ends of the locomotive cylinders.

The accuracy of the assumption that better temperature measurements could be made in the exhaust stand than in the exhaust passage was tested on a locomotive in main-line service. On this particular test an observer was riding on the front of the locomotive and simultaneous readings were taken of the exhaust-steam temperature with a thermometer in the exhaust passage close to the steam chest, and a thermocouple in the exhaust stand. The average of a number of readings showed the observed exhaust-passage temperature, as indicated by the thermometer, to be 345 deg. F. and the observed exhaust-stand temperature, as indicated by the thermocouple, to be 325 deg. F. In other words, if the exhaust-stand temperature is taken as being accurate the temperature measured in the exhaust passage close to the steam chest was reading 20 deg. high. This figure would vary no doubt with the class of engine and conditions of working, but it is evident that measurements taken of the exhaust-steam temperature in the exhaust passage close to the steam chest are subject to considerable error.

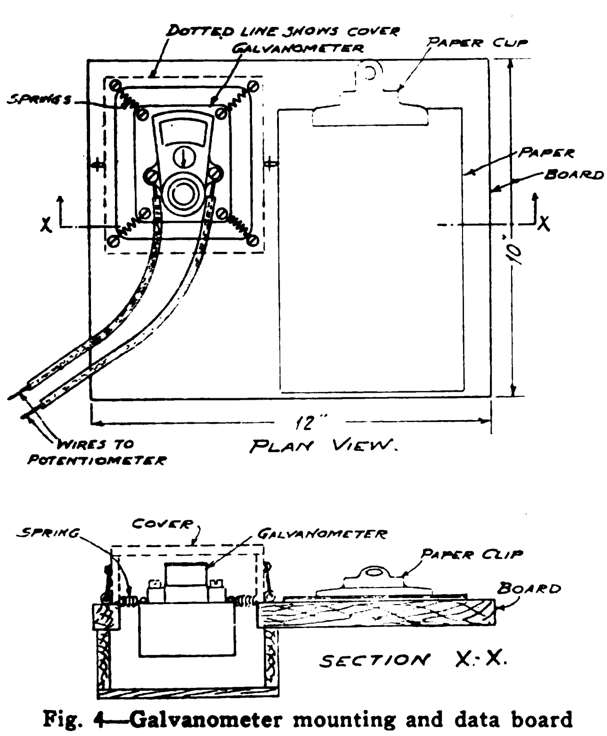


Fig. 4—Galvanometer mounting and data board

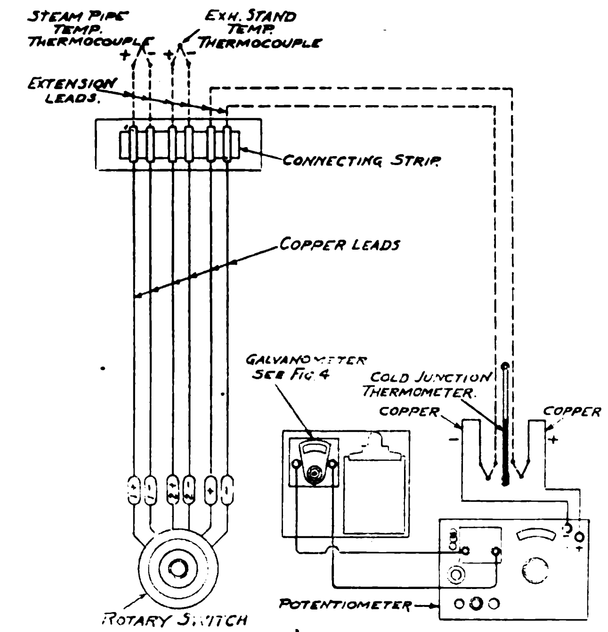


Fig. 5—Wiring diagram

The application of the thermocouple—constructed the same as in Fig. 2—to the exhaust stand is shown in Fig. 3. A ½-in. standard pipe is screwed into the exhaust stand and brought out through the smokebox front. The thermocouple is slid into this ½-in. pipe, which provides an insulating jacket and also permits easy removal.

The thermocouple electromotive force is measured with a Leeds & Northrup potentiometer, a well-known means of measuring temperatures in connection with thermocouples, and suitable for locomotive testing. Because of severe vibration there is always the possibility of a broken strand in one of the thermocouple wires, or a bad contact. With a direct-reading pyrometer this would throw the instrument off but with a potentiometer it would make no difference, as long as the wiring was good enough to provide a circuit.

With the galvanometer mounted in the potentiometer case as sent out by the makers, the vibration of the locomotive is sufficient to upset the galvanometer needle. In order to obviate this difficulty, the galvanometer is mounted on a board with a spring suspension as shown on Fig 4. This board, held by the observer, also serves for writing down the data. The observer's body will absorb most of the shocks from the vibration of the locomotives and, with the spring mounting of the galvanometer, no trouble will be found in taking readings. The potentiometer is mounted on a bracket and the galvanometer wired to the potentiometer by means of two copper wires of sufficient length to allow freedom of movement to the observer.

The thermocouples are connected to a rotary switch in the cab by means of which each one in turn may be put into the potentiometer circuit. The wiring diagram is shown in Fig. 5. A thermocouple measures the difference between the temperatures of the hot and cold junctions and consequently it is necessary to know the temperature of the cold junction and to connect the hot and cold junction in such a way that no other electromotive force is set up. As in Fig 5, the thermocouples

are connected with special extension leads to a connecting strip located at some convenient spot near the front of the locomotive. These extension leads are of the same material as the thermocouple wire, so that no electro-

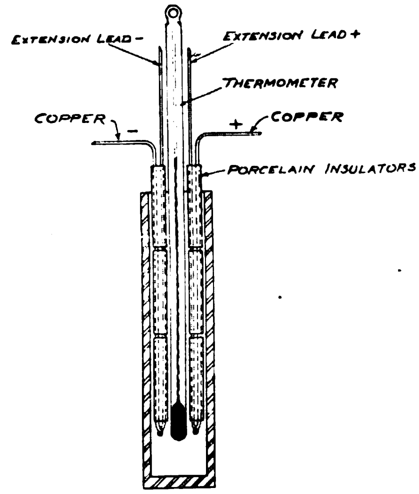


Fig. 6—Cold junction

motive force is set up at their junction. This connecting strip is mounted in a closed metal box, so that all junctions will be at the same temperature. From the connecting strip copper leads are run to the rotary switch in the cab. The common wires from the rotary switch, which are connected to each thermocouple in turn, are connected with copper leads forward to the connecting strip and from there connected with the special extension leads back to the cab. The ends of these leads are joined to copper wire, which is connected to the potentiometer. This junction of the extension lead and the copper wire forms the cold junction, Fig. 6, and is placed in a piece of ¾-in. pipe. The thermometer and cold junction will be at the same temperature and will not be affected by stray air currents. As many thermocouples as desired can be wired with extension leads to the connecting strip at the front of the engine and the single extension lead going back to the cold junction will automatically refer the cold junction from the connecting strip to the cab.

For accuracy in measuring the steam rate it is desirable to have thermocouples in both steam pipes and both sides of the exhaust stand. The temperatures should not vary much from side to side, but with the two sets of thermocouples a true average can be obtained.

Instead of using thermocouples the temperatures can be measured with even greater accuracy by using platinum resistance thermometers.

It has already been pointed out the heat drop from the steam pipe to the exhaust includes radiation from the steam pipes, steam chests, cylinders and exhaust passages. For a typical 4-6-2 type locomotive, this radiation loss has been calculated to be approximately 0.42 per cent of the heat drop with the engine standing still and 0.83 per cent of the heat drop with the engine running at 100 mph. This radiation loss can be allowed for, but it is obvious that inaccuracies in its determination will be negligible in its effect on the calculation of the steam rate.

Table I—Test of 2-8-2 Type Locomotive

Test No.	Tonnage	Speed m.p.h.	Cutoff, per cent	Steam pressure: Steam pipe, lb. per sq. in.	Steam pressure: Exhaust, lb. per sq. in.	Temperature: Steam pipe, deg. F	Temperature: Exhaust steam, deg. F	Steam rate, lb. per i.hp.-hr.
1	3779	30.7	44	149.9	11.2	641	318	17.59
2	3879	24.0	48	149.0	12.6	639	327	18.13
3	2016	42.4	40	147.7	12.5	597	291	18.62
4	3000	28.8	49	145.7	12.2	644	325	17.80
5	3532	27.8	48	144.2	11.4	628	318	18.34
6	2690	32.0	43	142.5	12.7	635	325	18.21
7	2629	34.3	42	142.9	12.5	633	320	18.09
8	2699	30.6	46	149.2	13.0	625	314	18.41
9	2819	29.3	44	144.4	13.3	621	306	18.22
10	3760	27.6	45	154.8	12.6	641	318	17.58
11	4200	27.3	46	155.7	12.6	632	306	17.40
12	3476	33.3	42	147.3	12.5	642	327	17.93
Avg.	3207	30.7	45	148.0	12.4	632	316	18.03
13	3637	29.8	49	159.2	13.0	707	357	15.80
14	3718	28.5	49	157.7	12.8	724	365	15.39
15	3680	33.4	47	165.5	9.7	710	354	15.68
16	3701	30.8	47	162.7	12.0	683	348	16.69
17	2966	28.1	49	164.0	13.0	716	367	15.87
18	2623	31.9	47	162.3	14.2	705	379	16.97
19	2660	38.0	47	156.7	14.3	692	352	16.40
20	3067	37.2	45	164.7	11.6	689	334	15.84
21	3789	31.4	47	161.1	12.4	680	347	16.92
22		32.0	45	160.4	11.2	677	357	17.53
23		36.9	43	163.7	10.0	666	347	17.71
24		37.6	47	159.8	14.5	718	395	17.21
25		29.8	45	159.4	12.4	712	375	16.48
26	2580	36.6	46	157.0	14.1	680	362	17.62
27	3670	26.3	55	156.8	14.0	690	367	17.21
28	3400	31.6	49	155.3	13.3	676	355	17.61
29	3382	27.7	48	160.3	11.3	693	354	16.48
30	4112	30.8	48	162.7	11.9	681	351	17.02
31	3354	31.7	48	162.7	13.5	690	357	16.79
32	2754	37.4	43	161.9	11.8	675	350	17.38
Avg.	3318	32.4	47	160.7	12.6	693	359	16.73

1—Tests 5 and 12 were made with 90 per cent throttle opening. All other tests were with full throttle.

2—For tests 1-12 boiler pressure averaged 16.3 lb. higher than steam pipe pressure and for tests 13-32 the average was 22.4 lb. higher.

Table II—Test of 4-6-2 Type Locomotive

Test No.	No. of cars	Tonnage	Cutoff, per cent	Pressure: Steam pipe, lb. per sq. in.	Pressure: Exhaust, lb. per sq. in.	Temperature: Steam pipe, deg. F.	Temperature: Exhaust, deg. F.	Steam rate, lb. per i.hp.-hr.
1	5	571	25	202	11.6	700	356	16.47
2	5	573	25	205	11.6	715	354	15.60
3	5	573	27	207	12.5	709	343	15.41
4	5	571	25	210	12.9	705	355	16.19
5	6	644	25	207	12.4	691	339	16.18
6	6	636	26	205	13.2	711	359	16.00
7	5	569	25	205	10.9	699	337	15.61
8	5	558	25	211	12.5	719	360	15.69
Avg.	..	587	25.4	207	12.2	706	350	15.89
9	6	643	25	213	11.4	748	360	14.37
10	6	643	26	211	11.5	749	359	14.28
11	6	644	25	214	10	748	356	14.21
12	7	715	26	213	13.6	749	371	14.79
13	6	643	25	210	13.0	748	362	14.40
14	6	643	26	209	13.3	745	358	14.38
Avg.	..	655	25.5	212	12.1	748	361	14.41

Road Tests of Locomotives

Table I shows the results obtained on road tests of a 2-8-2 type locomotive in fast freight service. The object of the test was to determine the effect on the engine performance of a special design of superheater unit. Tests, Nos. 1-12, were first run with the standard Type A superheater in place. The special superheater was then installed in place of the Type A and further tests, Nos. 13-32, were run. No attempt was made to obtain special conditions with reference to the running. The engine was in regular service, pulling whatever trains were assigned to it with various engine crews. The locomotive would run for half a division, take on water, and then finish the run to the end of the division. Each test shown in Table I is the average of readings taken every two miles for about 40 to 50 miles, representing about half a division. After starting, several miles were allowed before readings were commenced in order that conditions might become reasonably constant. A caboose was carried back of the locomotive as a test car. The thermocouples were all wired to the caboose, where the temperatures were read by an observer with the potentiometer and rotary switch. The wiring connection between the caboose and tender was arranged to be easily connected and disconnected. Temperatures were measured on the left side only.

The method of testing was successful and the readings obtained were consistent and reasonable. The increase in steam temperature with the special type of super-

heater showed a decrease in steam rate, in line with other tests. This will be referred to later, when the accuracy of the heat-drop method is discussed.

Table II shows the results obtained in a similar test on a 4-6-2 type locomotive in fast passenger service. In this case temperatures were measured in both steam pipes and in both sides of the exhaust stand. The variation from side to side was not very great, but was enough to be significant. The potentiometer and rotary switch were mounted in the cab and even at the highest speeds the galvanometer mounting shown in Fig. 4 was satisfactory. As in the test records in Table I the increase in steam-pipe temperature showed a decrease in steam rate, as would be expected. The readings of the steam-pipe temperature, exhaust-stand temperature, and steam rate are more consistent than those shown in Table I. This is because the weight of the train did not vary much. Only two crews were used for all the tests, and the time-table schedule was kept more closely.

Accuracy of Heat-Drop Measurement of Steam Rate

It is difficult to estimate the absolute accuracy of the steam rate as determined by the proposed method. In a number of tests, particularly those made at the Altoona testing plant of the Pennsylvania, measurements were taken of the exhaust steam temperature. This temperature was always measured in the exhaust-steam passage close to the steam chest, and, as already pointed out, the readings cannot be taken as being accurate. Consequently, it is not possible to compare the steam rate as obtained in these tests from the heat drop and as obtained from the indicator cards, except in a general way.

Some idea of the possible accuracy of the heat-drop method can be obtained from Fig. 7. In this figure steam rate is plotted against temperature in the steam pipe. Curve 1 is taken from Pennsylvania bulletin No. 24, published in 1914, entitled "Superheater Tests," the tests described being made on a Pacific-type locomotive. The only changes throughout the test were the length and arrangement of the superheater units. All points shown on Curve 1 are for a constant cutoff of approximately 40 per cent and a consistent speed of approximately 240 r.p.m. The steam-pipe pressure varied from 170 to 195 lb. Curve 2 is plotted from the results given in Table I. These tests were run at approximately 45 per cent cutoff, with a steam-pipe pressure of from 145 to 165 lb.

On account of the lower steam-pipe pressure it would be expected that Curve 2 would lie above Curve 1, showing a higher steam rate for the same steam temperature. The general trend of Curve 2 is the same as that of Curve 1. Another measure or indication of the accuracy of the results is the scattering of the points about the average line. It must be remembered that the tests for Curve 1 were made on a stationary test plant, with speed, cup-off, and horsepower closely controlled. The tests for Curve 2 were made in regular service, with a large variation in speed and tonnage, and with a number of different

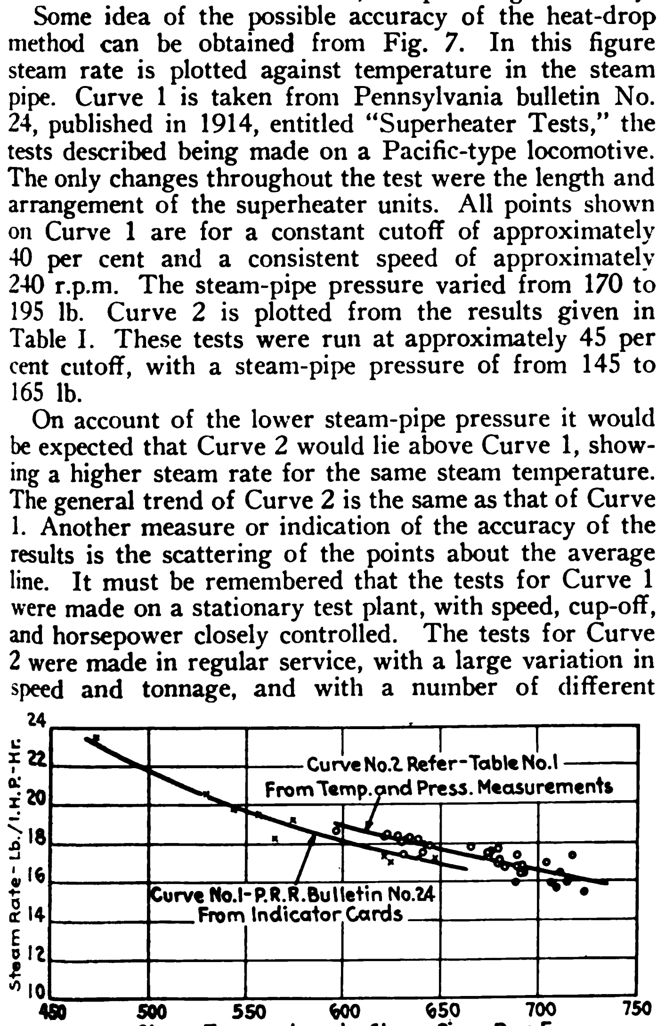


Fig. 7—Relation of steam rate and steam temperature

crews operating the locomotive. In view of this it is thought that the scattering of the points for Curve 2 compares favorably with the scattering for Curve 1.

Measurement of Indicated Horsepower

It was pointed out by L. K. Botteron, in the *Railway Mechanical Engineer,* July, 1930, that the exhaust nozzle of a locomotive could be considered as a flowmeter. From the exhaust pressure and temperature the velocity of the steam in the exhaust nozzle tip can be determined. Using the connections for pressure and temperature as shown in Fig. 3, it is necessary to apply a correction for the velocity of the steam at the point where the pressure is measured. The usual formula for determining the velocity of steam in a nozzle is

$$V_2 = 223.7\sqrt{H_1 - H_2} \qquad [1]$$

where V_2 = outlet velocity, ft. per sec.
H_1 = inlet heat content, B.t.u. per lb.
H_2 = outlet heat content, B.t.u. per lb.

In order to allow for the velocity of the steam at the point where the pressure is measured it is necessary to use the more exact formula

$$\frac{V_2^2 - V_1^2}{2g} = 778\,(H_1 - H_2) \qquad [2]$$

where V_1 = inlet velocity, ft. per sec.

From a knowledge of the pressure and temperature in the exhaust stand the quantity H_1 is determined. From a Mollier diagram the quantity H_2 is obtained, since the steam expands adiabatically and the entropy is the same at points 1 and 2. The pressure at point 2 is the pressure in the smokebox, and from the entropy and pressure the specific volume can be determined. Since the same weight of steam is flowing by points 1 and 2, the relation between V_1 and V_2 is

$$V_1 = V_2 \times \frac{A_2}{A_1} \times \frac{v_1}{v_2} \qquad [3]$$

where A_1 = area of exhaust stand where pressure is measured, sq. ft.
A_2 = area of exhaust tip, sq. ft.
v_1 = specific volume at inlet, cu. ft. per lb.
v_2 = specific volume at outlet, cu. ft. per lb.

Substituting this value of V_1 in equation [2] gives

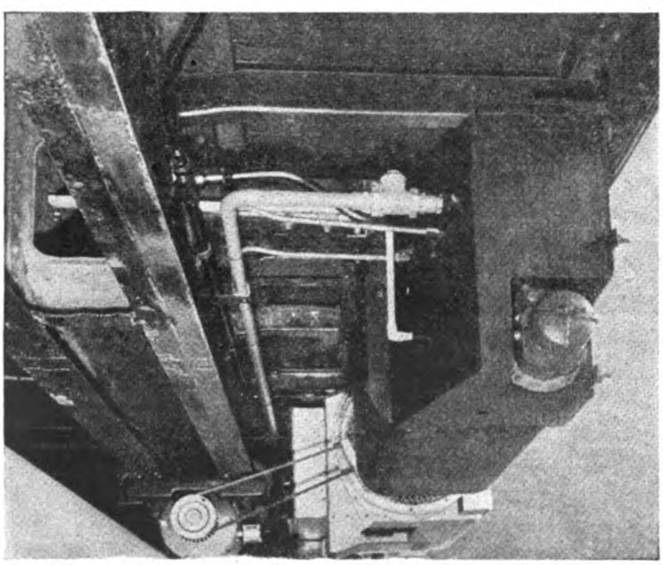
$$\frac{V_2^2\left\{1 - \frac{A_2V_1}{A_1v_2}\right\}^2}{2g} = 778\,(H_1 - H_2) \qquad [4]$$

from which V_2, or the velocity in the exhaust tip, can be calculated. The flow of steam through the exhaust tip is equal to the velocity multiplied by the area, multiplied by the density, multiplied by a coefficient. It was assumed in the article by Botteron that this coefficient would be unity. Using this assumption the author has obtained some results which agreed fairly well with the measurement of water from the tender tank. It is felt that for better accuracy it would be desirable to calibrate the exhaust tip by means of a standing or blowdown test. It would be possible for any railroad to establish the coefficient for their design of exhaust tip and then to use the exhaust-stand pressure and temperature measurements to give accurate readings of the flow of steam through the exhaust tip. By making suitable corrections for the steam flowing from the exhaust to the feedwater heater or exhaust-steam injector and for the steam flowing from the auxiliaries to the exhaust passage the weight of steam to the engine can be calculated with fair accuracy. These readings would give the flow of steam to the engines at any instant during a run. When the steam rate is known, as obtained from the heat-drop measurements, the indicated horsepower, at any instant, can be obtained by dividing the steam to the engines by the steam rate. This enables the indicated horsepower to be determined by measuring the temperature and pressure of the steam in the steam pipe and in the exhaust stand.

Pullman Air-Conditioning Holdover Feature

THE direct mechanical air-conditioning system, supplied by the Pullman-Standard Car Manufacturing Company, is designed to meet the full air-cooling requirements when train stops are frequent and stand-by power is available at terminals. To meet the condition of exceptionally frequent or long stops and inconvenient or inadequate stand-by power at terminals, an exclusive Pullman holdover feature has been developed and installed, as shown in the illustration. This consists essentially of a holdover tank from which an inexpensive solution of non-corrosive, non-poisonous liquid is automatically circulated through a coil adjacent to the evaporator whenever the train stops and the temperature would otherwise rise in the car. When the compressor is not cooling directly, it freezes ice out of this solution into horizontal ice columns. If the temperature rises in the car due to lack of power to operate the compressor, the cold liquid surrounding the ice columns is automatically circulated through a cooling coil by a thermostat which actuates a 32-volt motor-driven pump.

With the axle-driven compressor operating at full capacity it is possible to charge the holdover tank in 1¾ hours. The tank will then provide a cooling capacity which is about equal to that obtained by operating the compressor by a 12-hp. motor, which receives its power from a 1,000-ampere hour storage battery, starting at full charge and running until the automatic cut-off disconnects the motor at 27.5 volts. This amounts to a little more than half the total capacity of the storage battery. The remaining capacity is usually withheld from the compressor motor to provide insurance for car lighting and other auxiliaries.



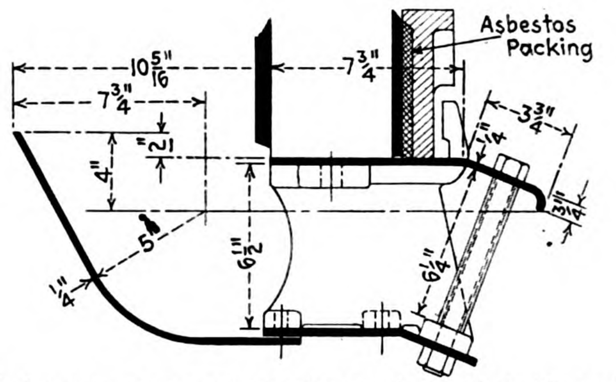
Partial view of Pullman air-conditioning equipment as applied underneath a car—Holdover tank in right foreground

This thermal storage unit of the Pullman system is simple and positive in operation, and can be repeatedly charged and discharged without detrimental effect. It is charged during the time when compressor operation is not required for cooling or in the yards before train departure. It is said to require little maintenance as the only moving parts are a small motor-driven pump and the control switches.

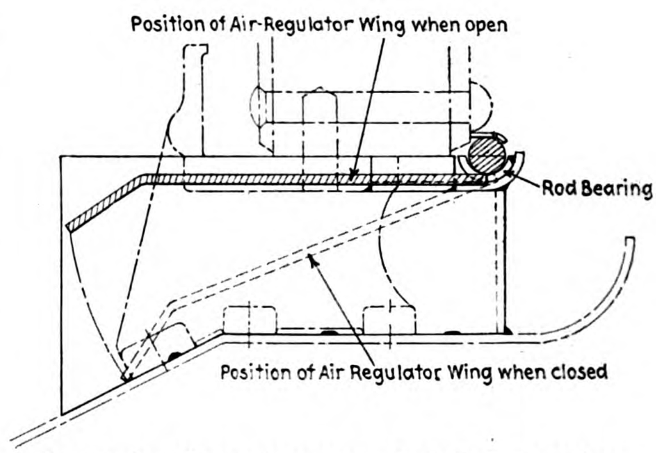
The holdover tank proves its value especially on runs with long stops, being automatically recharged enroute between stops. Continuous cooling is thus provided, as the compressor functions above 8 to 10 miles per hour and the holdover handles the cooling at speeds below this point and during stops. The Pullman direct mechanical system with the holdover feature is designed to afford maximum economy in producing continuous cooling and this method of storing energy is exclusively a Pullman feature.

Air Inlets To Ashpans*

THE Canadian National, which operates in severely cold districts, reports the use of an air deflector in conjunction with the ashpan. This deflector is bolted to the bottom of the mud ring. Its function is to deflect the cold air from the side sheet to a point where it must pass through the fire. This road also reports a method of packing the space behind the side grate carrier bar with asbestos, as shown in one of the illustrations, to eliminate the corrosion of the side sheet at the lower area caused by the products of combustion.



Air inlet to ashpan and asbestos packing behind side grate carrier bar on Canadian National



Automatic ash pan damper on C. & O. locomotives

A drawing was also submitted of an automatic ashpan damper designed to save fuel and to increase the life of firebox sheets. This damper has been in service on a few Chesapeake & Ohio engines for some time with results which have thus far been highly satisfactory. The operation of this damper will be easily understood from the drawing.

* Abstracted from a committee report on "Staybolt Leakage and Cracking of Firebox Sheets" submitted at the September, 1935, meeting of the Master Boiler Makers' Association, as given in the proceedings published in the October, 1935, issue of the Boiler Maker and Plate Fabricator.

EDITORIALS

1936
"Forward!" "March!"

"Why attempt to do something the 'Boss' does not want you to do?" Thus writes an officer of one of the so-called minor mechanical associations in reply to a suggestion that special efforts be put forth to revive the work of the association. Fortunately for the railroads, this is not the spirit in which most of the officers of the mechanical associations are facing the situation. The messages in the early part of this number clearly demonstrate this.

Far be it from the purpose of the *Railway Mechanical Engineer* to advocate that any supervisor or officer should seek a quarrel with his boss. Obviously any effort to press the necessity for promoting association activities should be conducted with tact and diplomacy. This is particularly true if it is known that the boss has a strong bias in the matter. On the other hand, a real boss, if he has administrative ability, can have nothing but contempt for yes-men. In large organizations there is always an inclination toward bureaucracy; this, in turn, is likely to encourage the development of yes-men—a tendency which has the same effect in eating into the vitality of an organization as has cancer in the human body.

If those who are heading up the mechanical associations really believe in them, and comprehend the good that can come from them, if properly conducted, then surely they can vigorously press the needs of these organizations in an intelligent way, which will not antagonize their superiors.

Difficult Problems To Be Overcome

Business conditions have very considerably improved in recent months. This is clearly reflected in increased traffic for the railroads and in improved net earnings. While it is unwise to attempt to prophesy, there seems to be little question but what these improved business conditions will continue well into the year, unless some great catastrophe takes place.

With a revival of business the railroad managements face many complicated and intricate problems. Very little new equipment or facilities have been installed for a number of years. Maintenance has been deferred wherever possible. Even under normal conditions this marking of time in improving equipment and facilities and in deferring maintenance would be serious. Added to it, however, we find that radical changes have taken place in the field of transportation during the years of depression—changes that may require new types of equipment, different sorts of facilities, and possibly radical changes in operating methods.

How are the railroads equipped to face this situation? Obviously, the most important factor is a well organized and trained supervision and personnel. The past five or six years have seen drastic reductions in the number of employees and this has also been reflected in the supervision. Younger men have been largely eliminated from the organizations and training methods have been slowed up, if not entirely abandoned. Many of the older men have left the service and the railroads will be hard put to it if within a short period they have to tackle a greatly increased business and reorganize and add to their forces.

A Question of Supervision

The mechanical department has been particularly hard hit and faces a serious situation, so far as supervision and personnel are concerned. Obviously, as conditions continue to improve, drastic steps must be taken to strengthen the supervision and to see that it is properly educated and coached. This problem may be tackled in different ways, depending upon the local conditions, but one of the most important factors in inspiring and setting a pace for better supervision will be by encouraging the activities of the highly specialized mechanical-department associations. Most of these organizations have splendid records of achievement behind them. Because of economic conditions they have been allowed to lie dormant for several years. Happily, in most instances their executive committees have functioned sufficiently so that, at the very least, the officers are still on the job. True, there has been a falling off in membership and the morale has been largely shot to pieces.

Mechanical Associations Should Be Revived

The revival of these associations, now that things are on the up-grade is, we believe, of extreme importance in assisting the railroads to inspire and develop their supervisory staffs. This, primarily, is the reason for using so large a part of this number of the *Railway Mechanical Engineer* for messages from the leaders of the various mechanical associations.

In a broad way these messages indicate some of the values of these associations. It is true that they do not attempt to discuss the advantages in detail, nor are the expressions the result of any thorough research. A study to determine the exact values of these associations would require more time and space than are available. It may not be out of place, however, to recite several incidents which are typical and which will give some idea of the different ways in which they may be helpful.

Examples of Helpfulness

The superintendent of a large railway repair shop had worked his way up from the ranks. He had a strong personality and real ability, and apparently was making good on the job. In some way, possibly at the suggestion of some of his friends, he attended a meeting of one of the so-called minor mechanical associations. He was pretty well along in years, was well satisfied with the job he was doing, and quite apparently attended the meeting only at the insistence of some of his acquaintances and without knowing exactly what it was all about and what he might expect from it. One of his friends frankly made the statement that he "didn't think the old man would get much out of it," because he was doubtful as to whether, with his extremely limited experience on one road, he would really be open-minded enough to take advantage of any suggestions which were developed.

When the shop superintendent went home after the convention things happened in his shop. He never missed another convention as long as he remained actively in service, and his shop became recognized as one of the very best of its type. It would be difficult or impossible to estimate the amount of money that his company saved by his improved performance.

A graduate of an engineering college served an apprenticeship on a midwestern railroad and eventually was made a roundhouse foreman. It was a 12-hour day, seven-days-a-week job. His college training had impressed him with the importance of making wide contacts and he insisted upon attending a convention of one of the minor mechanical associations. Incidentally, he had to do it on his own expense, but he was ambitious and fighting to get ahead, and felt that the sacrifice was worth while. He came back to the job all fired up, and with renewed energy and more intelligent effort made a record which so increased his value to the railroad that he was pushed rapidly ahead.

Another man, still fairly young, came into a minor supervisory position, working himself up from the ranks and having only a limited education. A wise mechanical department superintendent felt that the young man's value to the company could be greatly increased if he was given the opportunity of coming in contact with men in similar positions on other railroads, and in broadening his contacts. This man today holds an important position as a higher officer and acknowledges that the inspiration and help that he received from the conventions and the friendships there made, were an exceedingly important factor in fitting him for his present position.

An expert in one branch of the mechanical department, whose name is favorably known throughout the country, started many years ago on a western railroad as a fireman and worked his way up until he is today respected as an authority in the work in which he has since specialized. You will find him religiously attending meetings and conventions of experts from other railroads. Indeed, he insists that these contacts and exchanges of opinion are of vital importance, in order that he may keep up with the progress that is being made in his particular field. On a cold-blooded, statistical basis, the savings that have been made over the years on his road and in his department would present an astounding figure.

One might go on at great length with incidents of this sort. The minor mechanical associations do not duplicate the work of the Mechanical Division in the way of preparing standards and recommended practices. They deal, rather, with highly specialized problems in the different branches of the mechanical department, which are more or less continually changing because of the introduction of new equipment or changed operating practices. Members meeting with their associates from other roads, and debating with them, are kept up to date. Moreover, they know where to go when they get into difficulty and need advice, or wish to compare notes with men in like positions. Mechanical department supervisors, when they start for a convention, have certain specific problems that they are trying to solve; checking up with their fellows in the meetings, or outside of them in informal conversation, frequently leads to the solution of these problems.

Selling the Boss

The mechanical associations, rightly conducted, can be a tremendous asset to our railroads. No one knows better the value of these organizations than the supervisors who are interested in them and know how to use them. If the bosses do not appreciate these associations, then surely the supervisors can find some way of tactfully and diplomatically selling them to their superiors. Remember that your boss, if he is a real executive, does not want to be surrounded by yes-men.

An engineering college graduate, after several years of experience in the shop and in the designing room, went to another road as the mechanical engineer. He reported to a wise, hard-headed superintendent of motive power who had come up from the ranks and had never had a technical training. The mechanical engineer had an uncomfortable time of it, because he had literally to fight for almost every improvement that he wished to make in the design of the equipment. Frequently he grew discouraged and wondered whether, after all, it was worth while trying to make improvements. After a few years he resigned to go to another position.

Much to his surprise, the superintendent motive power expressed profound regret at his leaving. The mechanical engineer pointed out that a man had been in training under him, who could fill the position acceptably—indeed was a better engineer than he was. The S. M. P. replied, "Yes, maybe that is true, but he won't fight with me to get his ideas over. I have never had the advantage of a technical training and the only way in which I can check up on you technical men is to force you to fight to get your ideas over." Incidentally, this superintendent motive power had the

reputation of being one of the best on a road of its size in the country.

The above incident is cited in no disrespect to the S. M. P. No matter how well trained any officer of a railroad may be, he cannot be expected to understand all of the details in the great variety of activities under his general direction. The railroad mechanical department is so extensive in its variety of work that many specialists are required to head up the different types of activity. The officers, therefore, must have under them supervisors that they can trust and in whom they have confidence. In turn, however, these supervisors must intelligently, but persistently, in a diplomatic way, press their claims and see that the higher officers thoroughly understand all that is involved in their requests for support. This cannot be done by making broad or general statements; the supervisor must present his problems in a concise, intelligent way. He must be prepared to support his requests with sound logic and pertinent facts.

Executives' Point of View

A wise chief executive of a railroad demonstrated this quite conclusively at a meeting of one of the railroad clubs. A speaker had made a strong claim for certain improvements which he advocated in the mechanical department. In the discussion the chief executive said that he realized that such improvements were necessary, but did not believe the managements should be criticized quite so strongly for not adopting them. He pointed out that the chief executive had only a certain amount of money to spend for new facilities and improvements and that all the department heads were making requests for increases in their budgets or for capital expenditures. The chief executive, therefore, had to place the available funds where they could make the greatest improvement and earn the greatest return. It was, explained the chief executive, up to each department officer so to present his claims that they would receive proper recognition. If his department could really make better use of the money than other departments, then it was his failure if he could not get the fact over to the chief executive.

"Why attempt to do something the 'Boss' does not want you to do?" Possibly the boss's failure to recognize the importance of the claim is a measure of your inability to point out the importance of your association and its possibilities in the way of increased earnings for the railroad.

Objections to Convention Attendance

What are some of the objections made to convention attendance? In recent years, of course, the principal one has been the expense of attending such meetings. This, however, for a railway employee, is not very great, compared with men in similar positions in other industries. The railroad man has his transportation and the other costs need not be very high. Based on expenditures for other purposes it would seem that it must be a pretty poor convention, or a poor man attending it, if it could not many times justify the comparatively small expense involved. The time away from work is also one of the criticisms, but in a properly organized department this surely can be overcome.

Possibly the real reason why some of the higher officers look askance at conventions is that they believe they are big sprees. This contention surely is a severe indictment of the ability of the higher officers to select the right kind of men for supervisory positions. It must be admitted that some few men may not behave themselves as well as they might at conventions. The percentage of such men, however, is extremely small, and any one who has attended the conventions and followed their activities critically cannot but be impressed with the way in which the members participate in the proceedings and work hard to get everything they can out of them. If anything, a mistake is made in some instances in attempting to hold too long sessions each day.

Under the circumstances, can the railroads afford to eliminate so important a factor in the interests of efficiency and economy, because a few, or extremely small percentage of the members, do not know how to use the conventions properly?

There is a possibility, with the changes that have taken place in maintenance-of-equipment operations in recent years, that some of the associations may have failed to live up to their best opportunities, or have not been sufficiently keen in adapting their programs to the changing conditions. It would not be surprising if this were true in some degree, although one must admit, after studying the past performances of most of the associations, that they have been fairly successful in adjusting themselves to changing requirements.

With the long let-down it may be difficult for them to reorganize quickly to meet the new conditions. They may not be perfect and they may have shortcomings, but would it not be far better intelligently to encourage and help them, rather than to let their officers get the impression that they are not needed, or are not wanted?

NEW BOOKS

MECHANICAL WORLD YEAR BOOK. *Published by Emmott & Co., Ltd., 31 King Street West, Manchester, England. 360 pages, 4½ in. by 6½ in. Price 1/6 net.*

The 1936 edition of the Mechanical World Year Book includes, in addition to the various sections devoted to mechanical data on boilers, compressors, pumps, condensers, improved sections on machine tools and metals and alloys. A new section which has been included for the first time in the 1936 issue deals with the strength of tubes, cylinders and pans subjected to external pressure. This section has been included to meet the demand for information on equipment used for steam heating and contains many useful formulas bearing on this type of equipment.

THE READER'S PAGE

Alloy Steels in Car Construction

To THE EDITOR:

We have read with deep interest your editorial on "Alloy Steels in Car Construction," carried in your December issue. It strikes us that a great deal of good can come out of a discussion of this subject.

We note your comment with reference to the probability that weight reduction will be due largely to the resistance of these new materials to corrosion, and not so much to their increased tensile strength. It is our thought that the two can scarcely be separated. As a rule plain open hearth carbon steel has been stressed to around 16,000 lb., based upon its yield point of 30,000 to 35,000 lb., and now these stresses have been increased to 22,000 to 24,000 lb. when Cor-Ten has been used, based upon its yield point of 50,000 to 55,000 lb. Our experience indicates that there is a general desire to retain the full strength of conventional designs when building light weight equipment; hence, a steel having increased corrosion resistance without improved physical properties would not meet the requirements.

You also state that alloy steels cost more than carbon steel, and hence the first cost of light weight cars will be considerably greater than cars of conventional design and material. In this connection we wish to remind you of the recent announcement of the Pullman-Standard Car Manufacturing Company with reference to their welded Cor-Ten box car. Their headline that this car would be produced without added cost is significant. The added cost per pound of Cor-Ten over plain steel will not necessarily result in a higher cost for the light weight equipment.

We were happy to see this announcement of the Pullman Company because it indicates that modern design does not always demand an increase based upon the adoption of these better grades of steel. Should higher prices be asked unnecessarily, it would adversely affect the progress of the development, to the detriment of both the car builders and the producers of steel.

After giving consideration to the numerous economic factors involved in weight reduction we have come to this simple basis of reasoning: that common sense leads to the conclusion that a substantial conversion of dead weight into carrying capacity effects real savings which are bound to result in lower operating costs. This will be a complex problem only if it is made complex by specious reasoning, in those instances where it is thought necessary to justify the excessive weight of existing equipment.

We do not quite understand what was to be gained through anticipating that "no doubt in some cases the attempt at weight reduction will lead to too great a sacrifice of structural stiffness which may be the cause of expensive repairs during the life of the car." This is simply anticipating bad engineering. Perhaps there will be some bad engineering, but if so it must take the blame, not the steel used nor the fundamentals upon which the development is based. Your assumption of well balanced structures is the right and proper one, and your statement that the new materials will find justification in such designs is also right.

The final paragraph of your editorial deserves more attention than we care to give it in this communication. Some equipment should be designed with weight saving and added capacity as the most important objectives. In other cases added life and lower maintenance costs will justify the use of the new materials without reduction of section.

Let us repeat that we are glad to see editorial comment on this subject, and we are hopeful that it will precipitate a lively discussion, relating to this whole question, in your papers.

F. D. FOOTE,
Assistant to Vice-President,
United States Steel Corporation.

The Soviet Locomotive

To the Editor:

Many of those who are engaged in railroad work or related activities must have gotten quite a "kick" out of the description of the Russian 4-14-4 type locomotive in the November *Railway Mechanical Engineer,* and the editorial comment in the same issue.

Much water has gone over the proverbial dam since the day, in 1905, when I walked into your office for a chat on motive power. It seems to me that, even in those days, there were people who thought that the socialists ought to run the railroads—and about everything else, for that matter! They imagined that, by some hocus pocus, political radicalism could be metamorphosed into mechanical genius. I thought they were mistaken and I still do.

It is real nice of them, however, to admit today that they get ideas in the capitalistic U. S. A. This, by the way, is an interesting admission, since, by implication, it acknowledges that progress and opportunity are possible under a conservative economic and political system. Incidentally, a glance at the names of American railroad men will reveal a variety of racial origins—ample proof that merit counts and that the chance to shine is not denied to those who are willing to work.

Russia has the benefit of the accumulated experience of the most progressive industrial nations, but did very little on her own account. The idea of "mass transportation" originated among men who did not address each other as "comrade." They wanted efficiency as the means of building profitable enterprises to serve the public, reward investors and furnish livelihoods to executives and to labor. All things considered, they did very well until wild-cat motor interests invaded the highways, paying next to nothing for the privilege.

There were racketeers in the days of the Old Testament, as well as a variety of political, economic and moral theorists. It is almost startling to observe the close similarity between ancient and modern scoundrels!

The honest but untutored boy who does not know these things, sometimes falls a victim to the guile of a smooth talker who makes him believe that he would be wearing a silk stove-pipe and boiled shirt if Comrade So-and-So were in the White House. In point of fact, he would be knocking icicles off brake rigging in some remote and drafty engine house at the starvation wage decreed by Comrade So-and-So.

ARTHUR CURRAN.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Treating Men Right

I have found that it is best to cultivate the confidence of each man. Let him know you are with him and want to help him, and when you are in tight places—and you will be in an enginehouse—you will not be afraid to call on him. A few men can't stand good treatment, but you can easily make exceptions of them.

"Lap and Lead"

I have seen some timely articles on valves and valve gear in the *Railway Mechanical Engineer* and have learned a great deal from them because my knowledge of valve setting is not very well rounded out. I am about like the young "hogger" who came up for promotion and in the course of examination was asked if he knew what was meant by "lap and lead." Hesitating for a moment, he replied that he was unable to give a book definition, but the old 723 would lap up more coal and lead less box cars than anything he ever "took after with a scoop."

Brake Staff on Right-Hand Side

In a pleasant chat I had today with the Division Car Foreman at ———————— I told him of a repair track foreman, who did not wish to be quoted, who said that in at least one instance he had seen a brake staff on the right-hand side of the center line of a freight car. The Division Car Foreman confirmed this from his own experience with quite old equipment. So Marinac was not so far wrong in his recent cartoon (July, 1935), which disturbed several of your readers; and the bird being a trespasser might expect to have his tail feathers spanked, say I.

Let Foremen Design Locomotives

Not so long ago I saw an engine pull away from the out track at a roundhouse about 25 minutes late, because of a cylinder cock that had gone "haywire" at the last minute. The expression on the enginehouse foreman's face indicated that he wasn't at all pleased. About the only printable thing he said was that if ever he built a locomotive he would just be damned if they put any cylinder cocks of that sort on it. Shortly thereafter I was talking to another foreman, who had put in a fretful day pushing the work on a certain locomotive equipped with a gadget of doubtful merit; I was surprised to hear him say practically the same thing my friend had said of the cylinder cock. The thought struck me that these foremen must be rather outspoken in their likes and dislikes, and wouldn't it be something to see a locomotive built according to the likes and dislikes of foremen throughout the land? The idea would be to have the foremen fill out a questionnaire, specifying the details of said locomotive from A to Z, giving the style and size of everything from the "whistle to the rail," so to speak, including his pet style of valve gear, rods, crossheads, guides, cylinders and frames, driving boxes and shoes and wedges, style of superheater, feedwater heater, and, of course, specifying the proper cylinder cocks.

The boiler foreman should be heard from also as to the details regarding flues, staybolts and type of firebox and draft appliances; and by all means let the boilermakers give us that mudring corner that won't even leak, for which we have waited so long. After the tabulation was made, do you suppose the darned thing would run?

Keep on Fighting for Business

I think it is timely to prod up the employees' traffic or "ship by rail" clubs at this time and exhort all classes of employees to renew their activities in soliciting business. There should be no let-up along this line, just because business is improving. It is a case of keeping the ball rolling and never let that old "let George do it" spirit creep into the organization.

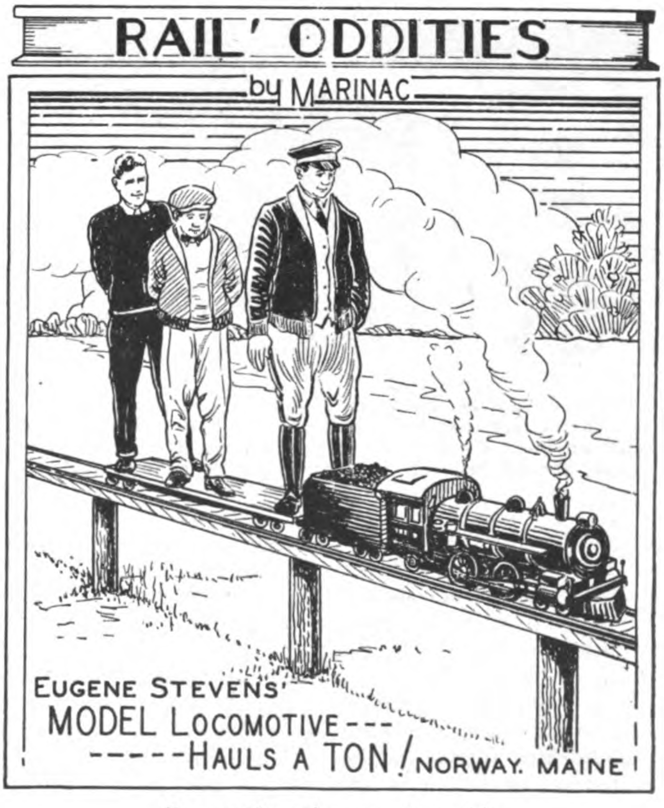
Walt Wyre Illustrations

Incidentally, I wish to congratulate you on what appears to be something of a new policy, with respect to the Back Shop and Enginehouse Department, which lends very considerable interest to the publication. It would appear that you have difficulty in finding an artist or a cartoonist who has sufficient service knowledge of mechanical matters properly to portray locomotive work, but it would seem that you have been quite successful with respect to the illustrations of Mr. Walt Wyre's story.

Traveling Fast

The London & North Eastern Railway London to Newcastle fast run is an amazing piece of work. On a trial run with the "Silver Streak," Gresley's three-cylinder Pacific made 43 consecutive miles at 100 m.p.h. and a top of 112½ m.p.h. But Mr. Gresley, like the French, will aim to maintain high uphill speeds so as to avoid much over 90 m.p.h. at any point in his run. And that is right. The French have operated on that principle for years. Of course, we are getting up into zones of pretty high averages. We talk of average speeds of 80 m.p.h. today as if it were a mere nothing. But it still takes some doing.

* * * *



For explanation see page 44

With the

Car Foremen and Inspectors

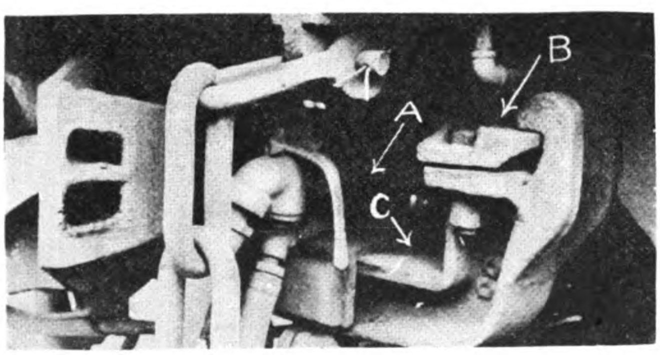
Eliminating Noises and Rough Riding of Passenger Cars

By H. K. Allen

Suggestions given for overcoming many of the conditions which cause annoyance to passengers

A FEW years ago passengers were content to accept the dust, dirt and cinders that accompanied their journey on a passenger train. They did not complain when the choking fumes from a tunnel came through the open window of their car accompanied with a shower of cinders. If they even noticed the squealing of center plates, the rattling of vestibule diaphragms or the groans from dry side bearings they probably thought of them as a necessary evil that must be expected when traveling on a train.

Within the short period of two years this has all been changed. The advent of stream-lined, air-conditioned passenger trains has convinced the traveler that a smooth, dust-free and reasonably quiet ride on a train is possible. Standard types of coaches, sleeping cars, lounge, club and diners have been placed in shops, air conditioned and generally overhauled in order to provide the same comfort and conveniences that have been provided on the newly acquired stream-lined trains. The passenger demands that this new service be furnished, the railroads have demonstrated that it can be furnished so it is now simply a matter of maintenance of the equipment. The responsibility rests with the terminal maintenance forces.



A—Pipe clamps that are loose will cause rattles; B—Loose carrier-iron bolts will cause a knock when rounding curves; C—Carrier irons, especially the floating type, should be well lubricated to prevent squeals on curves

There are numerous defects that contribute to rough riding and noisy conditions of a passenger car that cannot be discovered by the terminal car inspector. Such defects as steam pipe rattles inside the cars, berth squeaks or excessive bouncing of the car indicating a wheel that had worn eccentric should be reported to the terminal maintenance forces so that such conditions can be corrected before the car is again despatched.

In order to provide this information in some uniform manner one railroad has furnished each train conductor with a supply of printed forms of the following description:

REPORT OF PASSENGER CAR DEFECTS

TRAIN________ CAR NUMBER________ DATE______

Does car ride smooth?________

Did air conditioning equipment work OK?________

Was electric lighting equipment OK?________

Was car clean and sanitary?________

Were car windows clean when despatched?________

Did you notice any pipe rattles?________

Was there plenty of drinking and wash water?________

How did car ride on curves?________

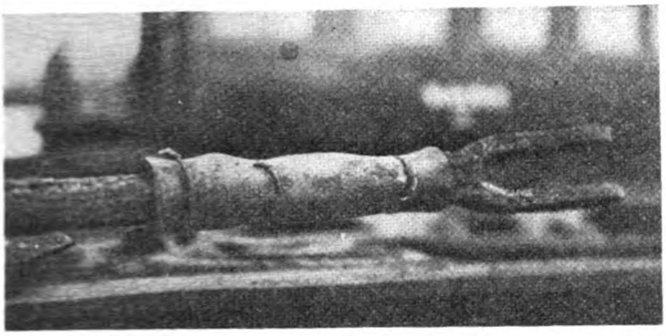
REMARKS: ________

____

*Signed*________
Train Conductor

This form is turned over to the station master by the train conductor upon the arrival of the train at the terminal. If there are any defective conditions reported the form is noted to the car foreman who must see that the necessary work is performed and he must personally initial the form before returning it to the station master for filing in his office.

There are many defects that do not impair the strength or safety of a car but which are responsible for noisy and rough riding conditions. Car inspectors should report these conditions so that they can be corrected before the car is again despatched. The principle causes of noisy and rough riding conditions and their preventatives are as follows:



A piece of air hose placed around the brake rod where close clearance prevails will deaden the sound of brake rods striking the underframe or center sills

Couplers and Parts: Excessive free slack in draft gears, worn pivot pins, or elongated holes in the coupler stem will cause jerks when starting or stopping the train. Where more than ½ in. of free slack is found the coupler should be dropped and necessary repairs made.

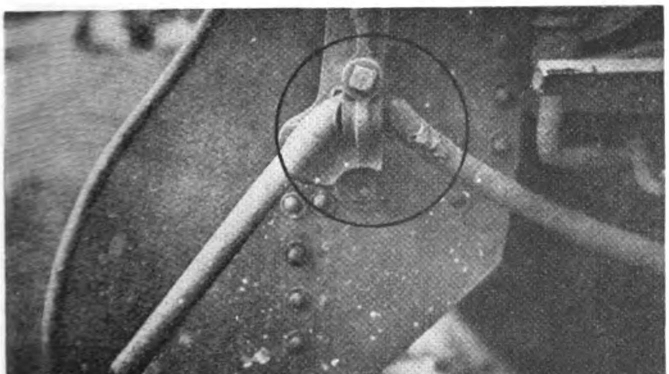
Carrier Irons: Coupler carrier irons should be kept tight. The surface where the sliding plate engages the coupler should be kept well lubricated with a heavy grade of grease to prevent squeals on curves.

Pipe Clamps, Brackets, Etc.: Pipe clamps and brackets that are not tight will permit the pipes to rattle and resound through the entire car. New bolts should be applied where the old one are found to have the threads worn to the extent that they cannot be again tightened.

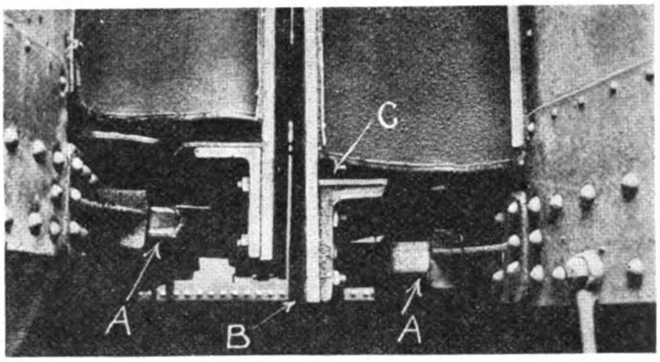
Brake Rods: Nothing is more annoying to passengers than the noise of a brake rod hitting against the sills or floor of a car. There are many places where there is very little clearance between the brake rods and the underframe of the car and unless some cushion is provided the noise cannot be prevented. A piece of rubber air hose cut lengthwise so it can be placed around the brake rod and secured with a piece of copper wire will deaden the sound of the brake rod striking the underframe. Where brake levers pass through the center sills a piece of oak wood secured to the lower rest with countersunk bolts will eliminate noise at this point.

Uncoupling Levers: Coupler uncoupling levers can produce a great deal of noise by sliding back and forth in the outside casting at the step apron. While the use of a lubricant will usually eliminate squeals at this point it will not eliminate the clanging noise that is produced when the uncoupling lever is in swinging motion. To correct this condition the uncoupling lever should be wound with electricians' friction tape where it passes through the bracket.

Buffer Stems: A large part of the noise produced in



Uncoupling levers should be wound with electrician's friction tape where they pass through the bracket at step apron to eliminate squeaks and rattles

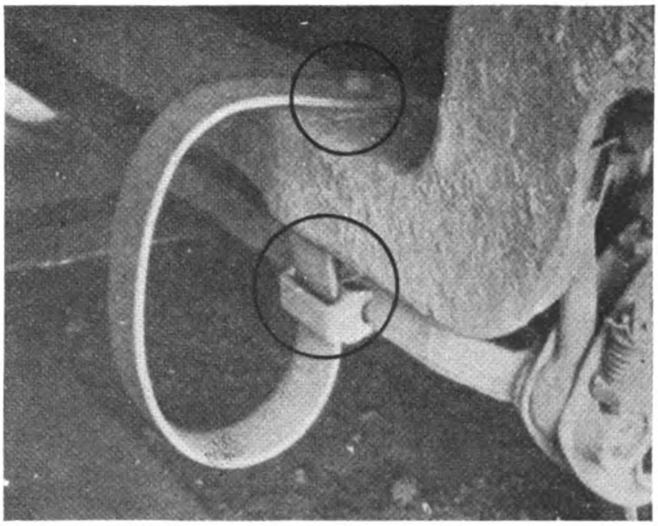


A—Worn buffer stems should be shimmed and kept well lubricated to eliminate squealing; B—Vestibule diaphragms should be adjusted to fit tightly together to eliminate clanging noises in the vicinity of the vestibule; C—Diaphragm foot plates should be of the same height to prevent passengers stumbling

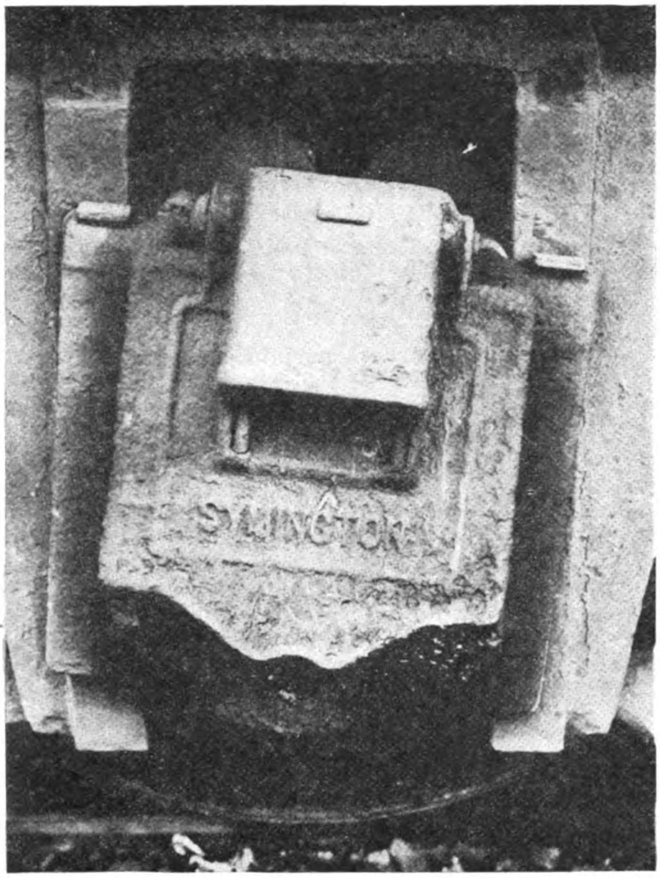
the neighborhood of the vestibule or the end of cars is caused by lack of lubrication of buffer stems. Unless a good grade of heavy lubricant is applied to the buffer stems at least twice each week they will cause a squeaking sound, almost continuously. Worn buffer stems, in addition to causing squealing will rattle when the train is in motion and produce a noise that can be heard through the entire car. Unless these buffer stems are too badly worn to retain in service they can be lined up with steel shims and the rattling eliminated. Buffer stems worn in excess of ½ in. should be scrapped.

Vestibule Diaphragms: Much of the clanging noise in the vicinity of vestibules is produced by the vestibule diaphragms not fitting together properly. Springs in the buffer stems should be compressed not less than 1 in. to insure a correct pressure between the diaphragms. When cars are despatched with the vestibule diaphragms standing apart as shown in the illustration there will be a continual clanging sound produced. Diaphragm foot plates should be of the same height to prevent a passenger from stumbling when proceeding from one car to another.

Brake Beam Release Springs: Loose brake beam release springs will cause an annoying rattle under the car. These springs are usually secured to the truck frame with a single bolt These bolts frequently work loose and when they cannot be retightened due to wear on the threads, they should be renewed. The release spring clips that hold the spring to the brake beam must be maintained in a tight position to prevent rattles, and



Loose brake-beam release springs will cause annoying rattles under the car



Worn journal boxes or pedestals should be renewed or the worn surface between the box and side wall lined to prevent severe knocks when air brakes are applied

to prevent the brake beam from riding on the tread of the wheel which will produce a continuous grinding noise.

Worn Journal Boxes and Pedestals: A journal box that does not set squarely in the pedestal indicates that it is worn or that the pedestal itself is worn. This condition provides a space between the side wall of the journal box and the wearing surface of the pedestal and when air brakes are applied will cause the journal box to strike against the pedestal leg and produce a severe knock which will resound through the entire car. Where the pedestal leg is worn it should be removed and a new pedestal applied. Where the side wall of the journal box is found to be worn it can usually be repaired by inserting a steel liner on each side of the box.

Center Plates: Truck and body center plates that are loose will cause poor riding conditions on curves. This condition will permit the body of the car to slide toward the high side of the curve and produce a dull thud when the center plate strikes the bolster web. On many cars it is difficult to inspect center plates properly because of the close clearance between the two center plates. For this reason passenger cars should be raised every six months and the center plates tightened. If bolts of less than 1 in. diameter are found in center plates the center-plate-bolt holes should be reamed and larger bolts applied as smaller bolts will not remain tight at regular speeds on severe curves. Center plates should be lubricated with either dry graphite or a heavy lubricant having a graphite base at least once every six months to eliminate grinding noises that will become evident if center plates are dry. Male type center plates that are found with the male portion worn in excess of 1/4 in. should be renewed. Female center plates found with the outside rim worn in excess of 1/4 in. should be renewed. This condition will result in lost motion between the two center plates

Loose or worn center plates will permit the car body to slide towards the high side on curves and produce striking noises

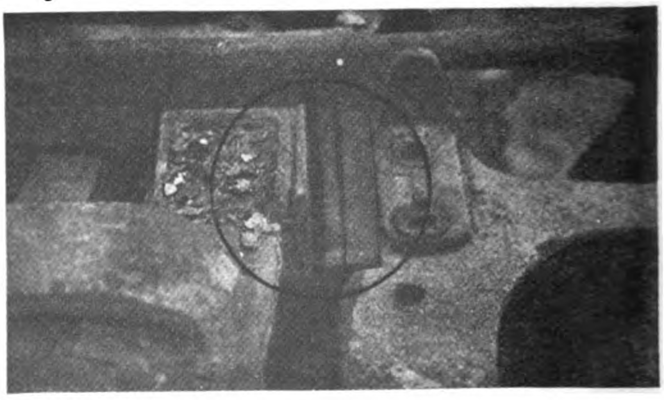
and cause them to slip on curves and produce a loud knock.

Side Bearings: Side bearings should be adjusted so that there is not more than 1/32 in. clearance between each side bearing. If there is less clearance the side bearings should be adjusted. Cars with side bearing clearance in excess of 1/32 in. will sway on curves and the roller in the truck side bearings will cause a rattling noise. Side bearings should be lubricated daily with a heavy grease having a graphite base. This will eliminate squeals on curves.

Truck Chafing Plates: The term "shimmying" as applied to a passenger car is caused by one of two defects. An eccentric wheel or too much clearance between the truck chafing plates. Chafing plates should be adjusted with a clearance of 1/16 in. to 1/8 in. between each set of plates. A heavy lubricant with a graphite base should be applied between the chafing plates every two weeks to prevent corrosion and subsequent binding.

Wheels: Care should be exercised in selecting wheels for application to passenger cars. They should be carefully taped to determine that each wheel is of the same circumference, as a mis-mated wheel will cause a drag on the smaller wheel at speeds in excess of 50 m.p.h. Wheels should be gaged for eccentricity for the reason that a single pair of wheels that is only a fraction of an inch out of round will cause the car to bounce and shimmy at a speed of 50 m.p.h. or more.

Finally, an adequate terminal maintenance force should be provided at the principle terminals where passenger cars are serviced in order to maintain the passenger equipment to the highest degree of perfection for the reason that the defects enumerated above are such that constant attention is required to eliminate complaints from passengers due to noises or rough riding of the equipment.

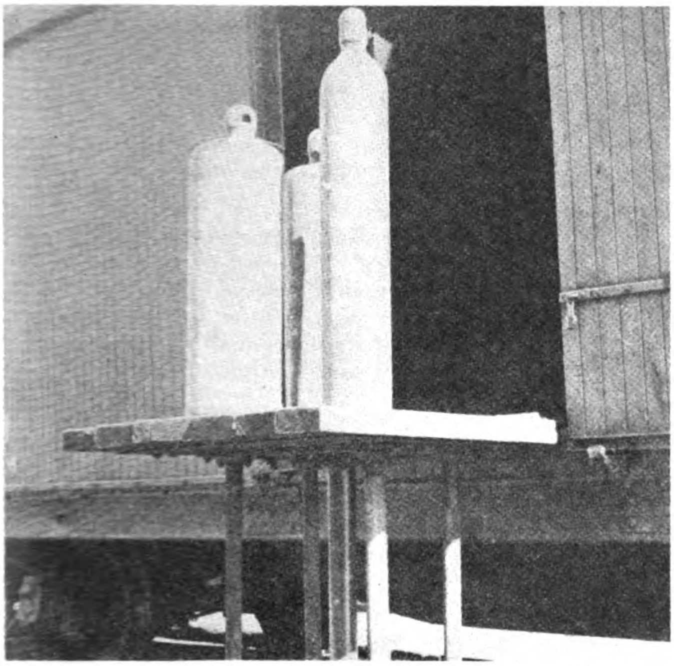


Truck chafing plates should be adjusted with a clearance of from 1/16 in. minimum to 1/8 in. maximum and kept well lubricated to prevent binding

Pneumatic Lift for The Car Shop

IN order to eliminate the use of ramps or runways at the car shop the pneumatic lift shown in the illustration was installed by the car foreman on one railroad. This lift was located adjacent to the oxy-acetylene plant, which was on the ground level, and can lift 10 oxygen cylinders from the ground to the level of a box car floor.

The lift consists of a 12 in. by 48 in. air cylinder which is placed in a pit below the surface. Four 3-in. staying rods are attached to the base of the platform and prevents it from turning. The platform is made from ½-in. boiler plate and is covered with 2-in. oak flooring boards. A hinged steel plate which is attached to the platform on the car side is lowered to the car floor after the platform has been raised. This eliminates any opening between the platform and the floor of the car. The lift is kept in the lowered position when not in use so that trucks can be freely operated over it. An ordinary air brake valve may be used to control the air to and from the cylinder for raising and lowering the platform.



An air lift facilitates the loading of oxygen cylinders

Shop Trucks Save Time and Labor

*By Frank B. Wildrick**

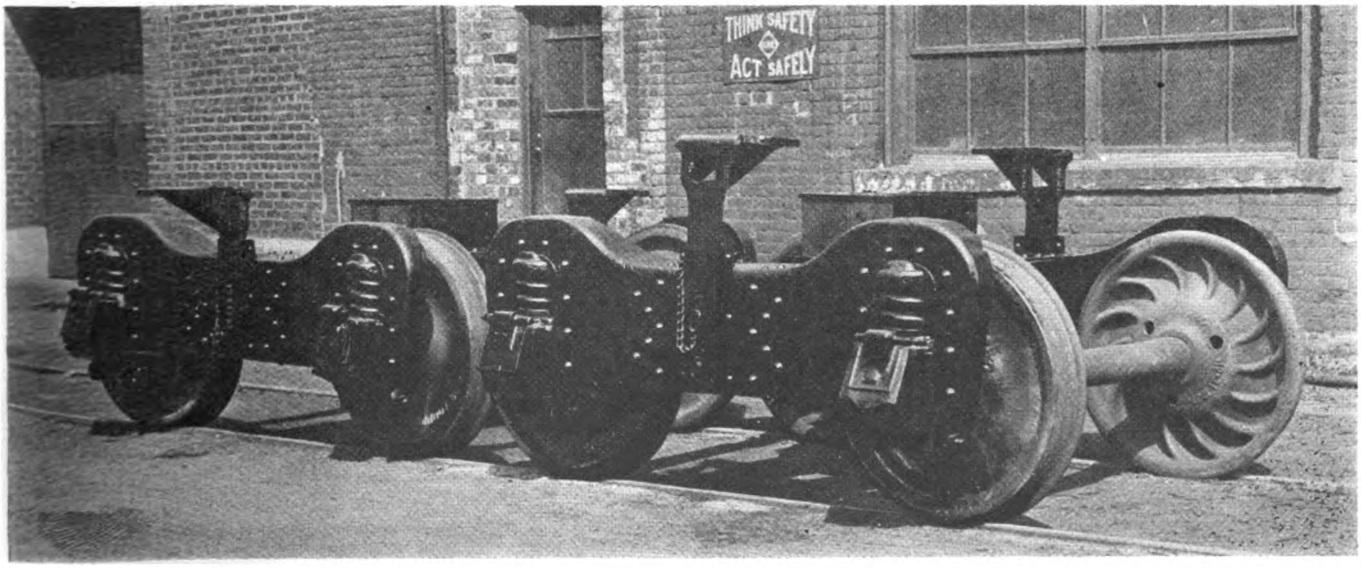
AN improvement in shop or "dummy" trucks used to replace original trucks undergoing repairs while cars are progressing through the different shopping positions at the Erie's Susquehanna passenger car shop is shown in the illustration.

The former practice was to place a cross timber on the truck, then fasten it to the center plate for the particular types of car and nail on varied blocks of wood as might be necessary to give proper side bearings. This meant keeping on hand a stock of center plates of all types as well as a quantity of timber and blocking and involved repeated lifting, nailing, adjusting and removing of blocks to obtain the required heights.

This continual re-handling has been eliminated by fastening a block permanently in the center of the truck, with a center pin hole concave and adjustable in diameter by the use of thimbles of various thicknesses. This does away with the need for carrying the many kinds of center plates. By attaching two square-topped lifts, one to each side frame, with the uprights slotted at short intervals vertically corresponding to slots cut in the side frames, so that by means of wedges inserted in the slots and through the frames, the lifts can be adjusted and held to any height required. These lifts can also be turned around so that the square-topped area is available horizontally in sufficient spread to take care of all types of side bearings.

The heavy work involved in handling timbers and metal plates is thereby reduced to the original application; after that the trucks are permanent in character and are available for instant and easy use for any kind of car that may come on the repair track.

* Material supervisor, Erie Railroad, Cleveland, Ohio.

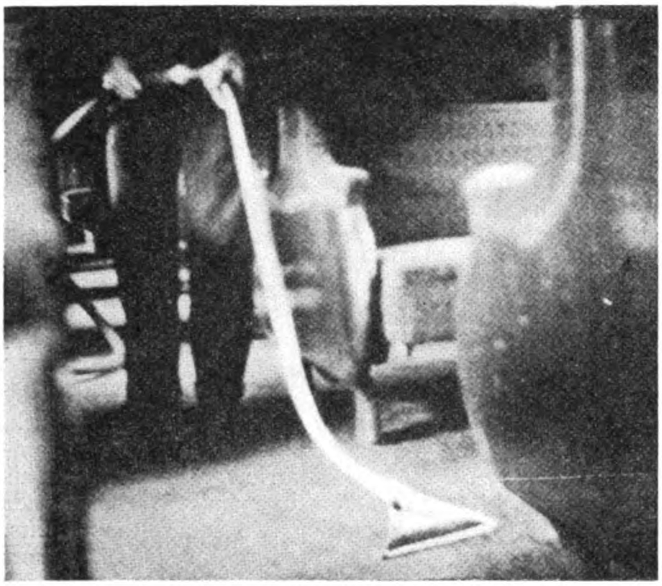


Shop or dummy trucks now being used at the Erie's Susquehanna passenger-car shops

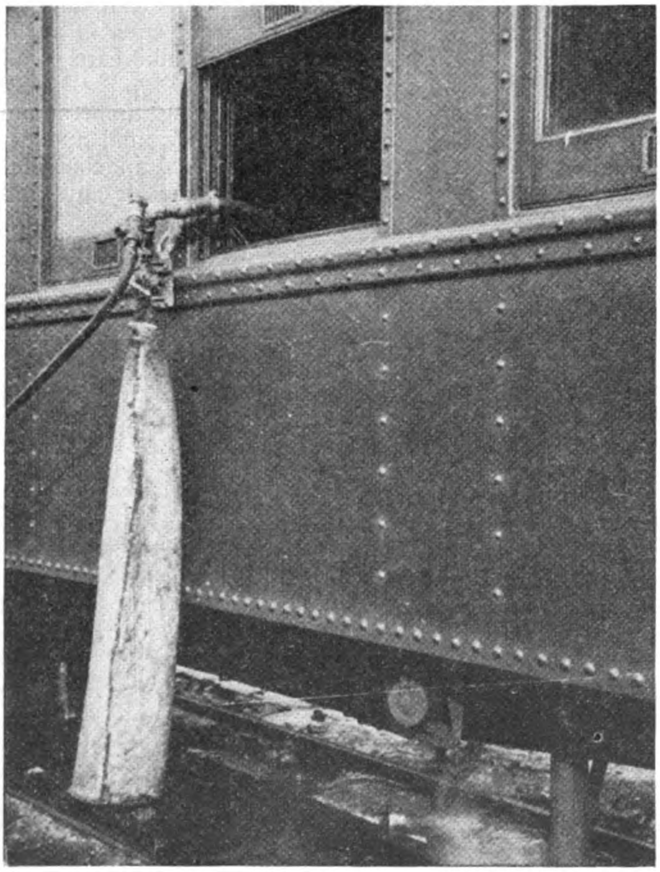
Carpet Cleaning

CARPETS in passenger cars can be cleaned without removal from the car by means of a vacuum produced through the use of a syphon jet fastened in a car window opening. Compressed air from a yard line blows through the jet creating a vacuum in a suction hose inside the car. Dirt is drawn out of the carpet by this vacuum and discharged into a muslin dust bag or strainer outside the car window. A bent handle on the vacuum tool facilitates cleaning under the seats.

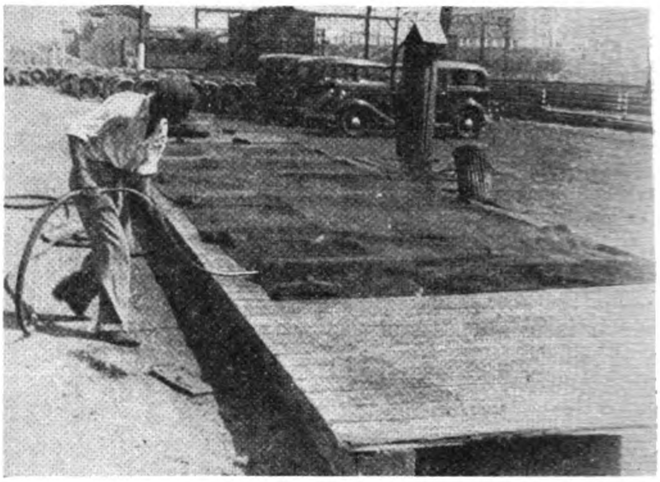
For outside cleaning with compressed air, the carpet is laid on a solid floor and compressed air from a pipe, which has been connected to an air hose and thrust under carpet, is jetted between the carpet and the platform. This air jet causes the carpet to vibrate or flap violently against the floor, bringing the deeply imbedded dirt from the base of the tufts to the surface where it can be easily blown off. The method is more effective than beating and also less injurious to the carpet.



Special vacuum tool for cleaning carpets



Syphon jet—Using compressed air to create a vacuum

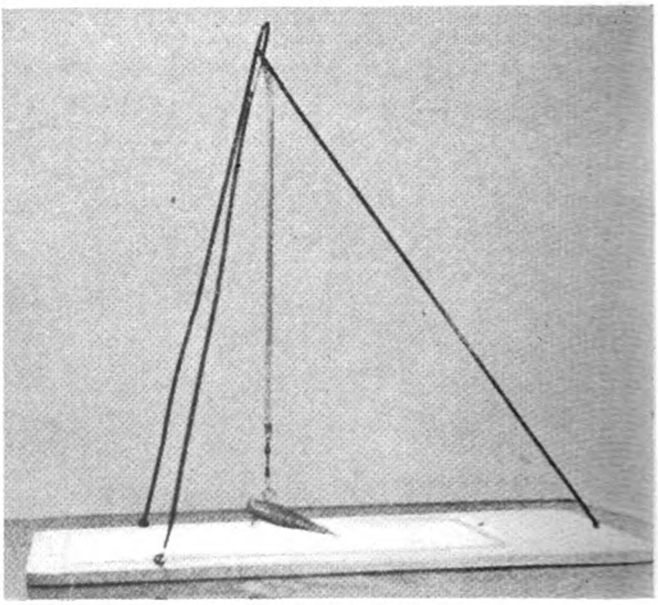


Vibrating the carpet by a jet of compressed air underneath —Note cloud of dust rising above jet

Rough Riding Indicator

IT is often desirable to check up on the riding qualities of a passenger car without involving the expense of sending a mechanical inspector or qualified observer out on the train. This can be done by the use of a simple device placed in the locker of the car which records the amount and severity of horizontal and vertical motion.

The device consists of a drawing board on which a hinged tripod of wire is fastened which supports a lead plumb bob at the end of a coil spring. The point of



Simple indicating device used in checking the riding qualities of a car

the plumb bob rests on a sheet of onion-skin paper held down on top of a sheet of carbon paper by thumb tacks.

Horizontal motion is recorded by the stylus or point on the end of the plumb bob moving about on the paper, the carbon paper leaving a mark on the lower surface. Vertical motion is shown by the number of dots made by the point near the upper end of the plumb bob striking the paper when there is any appreciable up and down motion to the car.

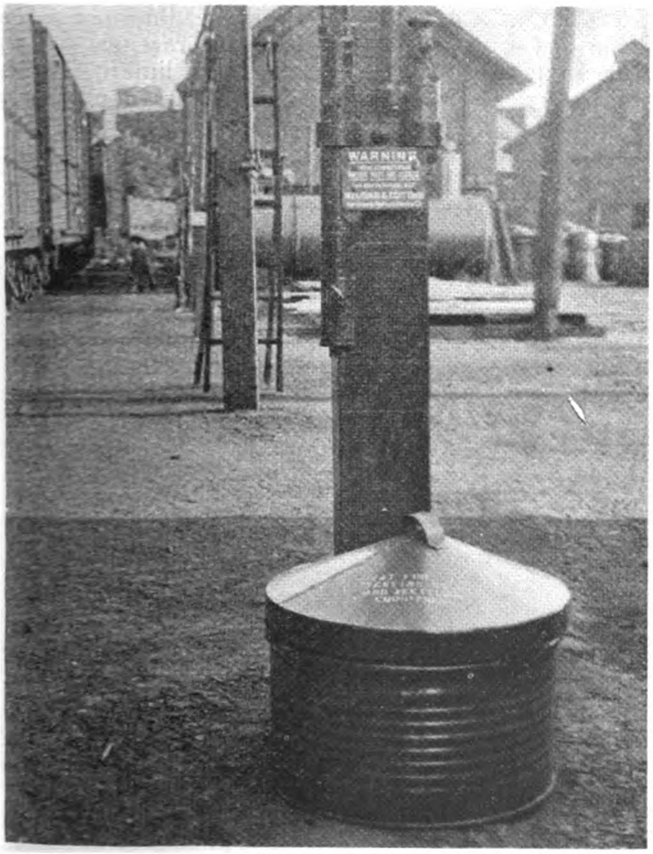
To distinguish between the rough riding due to rough track and that due to defective truck adjustment, identical outfits can be placed in two or more cars on the train. An excess of side or vertical motion in any one car indicates defective truck conditions, as the track condition affects all cars alike if the trucks are in equally good condition.

At the end of the trip, one leg of the tripod is unhooked and the device folds flat for ease in carrying.

Vat for Testing Cutting Outfits

A VAT, filled with cold water and located under each oxygen and acetylene connection, has been provided by the car foreman on one railroad for the purpose of having the oxy-acetylene outfits—including the torch and hose connections—tested before the burner or welder starts to work.

Where leaks are detected the connection is tightened and again tested. If it should develop that the torch is defective, a repaired one is drawn from the tool room and the defective one turned in. This precaution will not only eliminate many accidents due to back-fire but will eliminate waste of oxygen and acetylene.



The practice of testing cutting torches and hose before use reduces accidents and saves gas

The vat can be of any size and depth desired. However, the one shown in the illustration was made from the bottom portion of an unreturnable oil drum. The lid was made locally by the sheet metal worker and should be provided to keep out dirt when the vat is not being used for testing purposes.

Reclamation of Brake Beam Struts

By A. Skinner

AFTER a brake beam has been in service for a certain length of time, the hole in the strut becomes out of round due to the wearing action of the pin which holds the live truck lever in place, and, when this occurs, the brake beam must be removed from the car and another beam with a good strut applied.

It was formerly the general practice to scrap these worn struts, after they were removed from the brake beams, as no facilities were at hand to rebore the holes so as to restore their original contour. This need was met at one large reclamation shop by means of an ingenious shop-made device, as shown in the illustrations.

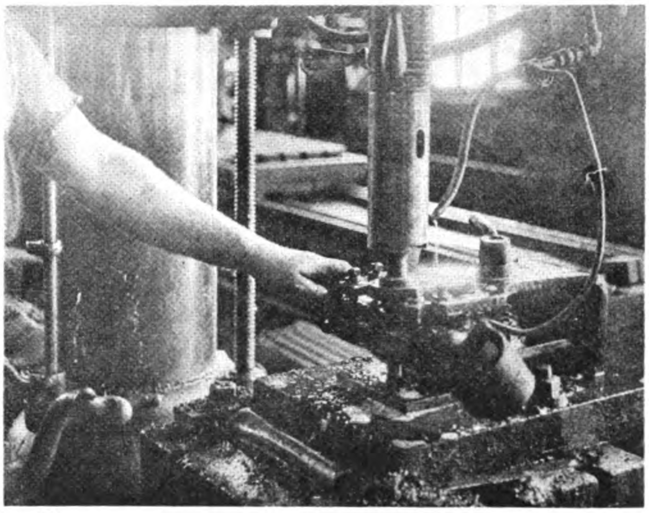


Fig. 1—Boring bar in the raised position showing cutter arrangement and upper guide bushing

Referring to the first view, the jig will be seen set up on a radial drill press with a strut in place ready to be bored. The jig consists of a substantial steel base, rigidly bolted to the radial drill base plate and provided with a horizontal steel plate, or dummy live truck lever, over which the strut can be applied and accurately positioned.

The strut is rigidly held in place by means of the angle bracket and handle-nut illustrated, full bearing against the strut being secured at four points by means of the set-screws illustrated. A special boring bar and cutter arrangement, shown in detail in the raised position in the second illustration, is accurately centered and guided during the boring operation by means of the slip-bushing which fits in a suitable hold in the upper angle bracket, the lower end of the boring bar being guided by means of a bearing in the base plate. The cutter is 1½ in. in diameter, the strut being bored to that size in order to clean up the hole. After the strut is bored, a steel bushing .001 in. oversize is driven into the hole on each side of the strut, by hand- or pneumatic-hammer.

By the use of this device, an average output of 108

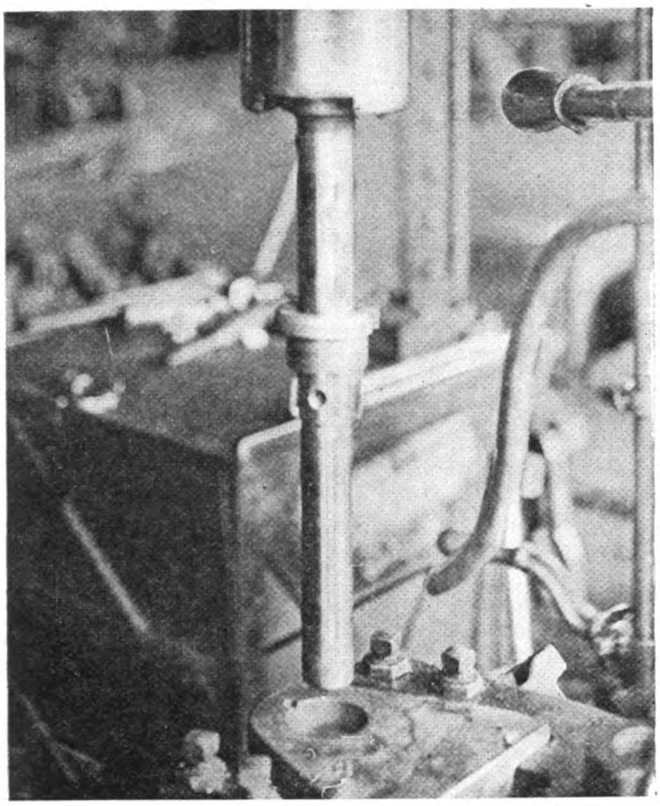


Fig. 2—Special boring jig used in reclaiming brake beam struts with worn live truck lever holes

struts per eight-hour day, or 13½ struts per hour, is obtained. The service life of struts bushed in this manner is greatly increased and a smaller number of brake beams will have to be removed from cars due to strut holes being out of round. The use of brake beam struts with accurate live-truck-lever holes, due to the application of new steel bushings, also has a tendency to keep the levers in proper alinement.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Repairs on Authority of Defect Cards by Other than Owner—Paint Damaged by Fire

Defect cards were issued under Chicago Interchange Bureau rules against the Chicago & Illinois Western for paint damaged by fire on sides, ends and sills of 38 L. & N. and 3 St. L.-S. F. cars. The Chicago, Indianapolis & Louisville, in whose possession the cars were when defect cards were issued, painted the burned parts and rendered bills amounting to $130.43 and $4.50 against the C. & I. W. The C. & I. W. contended that painting was not necessary for safety of trainmen or lading and as the C. I. & L. was not the owner, they were not authorized by interchange rules to make repairs and render bill therefor. The C. I. & L. contended that regardless of fact that repairs were not necessary for safety reasons, they were responsible for condition of all cars on line and were justified in billing for work performed.

The C. & I. W. in its statement contended that the charges rendered by the C. I. & L. were not authorized by the rules based on paragraph "A" and footnote to interchange Rule 1, the last sentence of paragraph "B" of this rule, and Rule 16. Paragraph A requires that each railroad give all cars on line equal care, inspection, oiling and running repairs. The footnote defines running repairs—which are the only ones permissible under this paragraph—as those ordinarily required to trucks, brakes, draft members, couplers, draft gears, and safety appliances. The last sentence of paragraph B, Rule 1, limits repairs which carriers may make to foreign cars to the minimum necessary for the safety of lading and trainmen. These rules, in their opinion, clearly indicate the intent that carriers may repair only such defects as constitute a safety hazard and, while they refer to owner's defects, the intent should be the same where the defects are of delivering line responsibility. As the defects on these cars, consisting only of paint burned, would not prevent safe operation, there was no reason why repairs could not have been deferred until cars reached home line. They, therefore, considered that the C. I. & L. exceeded their rights and that charges should have been cancelled.

The C. I. & L. stated that cars in question were in their service transporting coal from mines to Chicago and that it was their duty to give such cars equal care, inspection, oiling and running repairs. When cars were being unloaded by industries located on C. & I. W. they were damaged by fire to such an extent that it was necessary to paint same to preserve parts from further deterioration. Chicago Car Interchange Bureau defect cards were issued against C. & I. W. and we elected to make necessary repairs rather than order cars home and have them removed from revenue service. Rule 16 mentioned by the C. & I. W. as limiting repairs which carriers may make to foreign cars applies only to owner's defects. Rule does not permit repudiation of defect cards when repairs are made by carrier other than owners. The Arbitration Committee has already decided that defect cards once issued cannot be repudiated. It seems to us that as far as delivering road is concerned it does not matter who makes the repairs on authority of their defect cards, the owner or some other carrier. Furthermore, the L. & N. wrote to us: "If repairs made by you on authority of defect card conforms to original construction (two coats of paint), I do not see where we have any right, under the Interchange Rules to object to your making the repairs." As defect cards were properly issued for delivering line defects and repairs were made to conform to original construction and the L. & N. permitted them to make such repairs, they joined with C. & I. W. in presenting the case for consideration.

In a decision rendered November 8, 1934, the Arbitration Committee said: "Instead of making repairs, the Chicago & Illinois Western delegated the work through the issuance of its defect cards. While Rules 1 and 16 do not authorize repainting of foreign cars simply for the purpose of preventing deterioration, the repairing line evidently felt that it was serving the best interests of the car owner and, as no evidence is presented to indicate car owner's objection to action of the repairing line, bills as rendered on authority of the defect cards should be honored."—*Case No. 1739, Rules 1 and 16, Chicago & Illinois Western vs. Chicago, Indianapolis & Louisville.*

In the

Back Shop and Enginehouse

Repairing Pneumatic Hammers

Repair work on pneumatic tools for the Pennsylvania System is centralized at four regional shops located at Altoona, Pa.; Wilmington, Del.; Pitcairn, Pa., and Logansport, Ind. This article describes the manner of handling repair work on pneumatic hammers at the Pitcairn air-brake repair shop which takes care of the requirements for the Central Region.

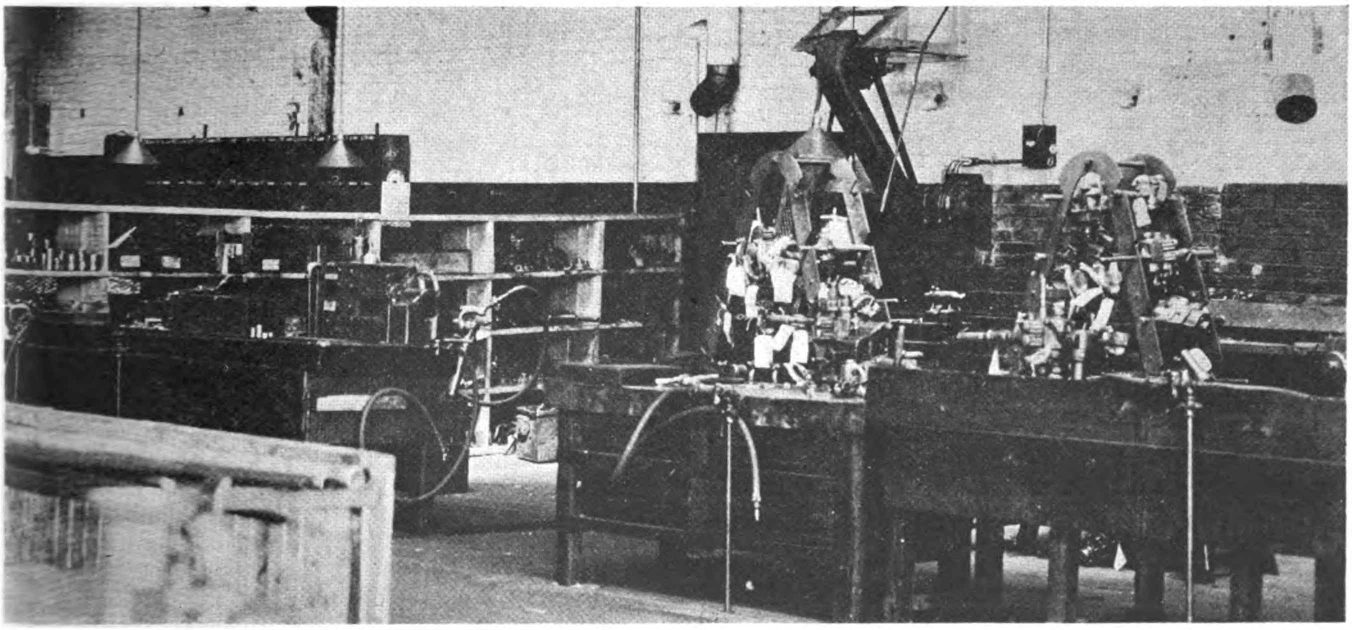
Under Pennsylvania practice no specified time is set for tools to be sent to the central shops for repairs. The shopping of such tools is dependent upon their functioning and, when they fail to function properly, they are sent in for repairs. Only minor repairs are permitted at outlying points. These consist principally of (1) cleaning and oiling the main valves; (2) renewal of pistons (on riveting hammers); (3) renewal of the trigger; (4) the regrinding or renewal of the throttle valve and spring. Repairs other than these are handled only at central repair shops such as Pitcairn.

In order to avoid confusion pneumatic tools are handled on what is known as the repair-tag system. A tag consisting of three parts is used for this purpose. On one side of each part are entered the shipping instructions and on the reverse side an identification of the tool shipped and notations as to its defects. One part of the tag is attached to the tool to be repaired; another part is turned over to the stores department; the third part is retained at the shop which ships the tool for repairs. These tags bear serial numbers and provide a valuable record in tracing lost shipments as well as an indication of the last date on which repairs were made to the tools. A record showing the serial numbers of the tools, the dates received and returned, and the nature of the repairs is kept of all tools received at the central shops. When the tools arrive at the shop they are tested (provided they are not broken or damaged) to determine their condition and the extent to which they may be operated. Upon disassembling the tools are given further careful inspection.

Repairing Pneumatic Hammers

After the initial inspection and testing has been completed the hammers are disassembled and cleaned with a turpentine substitute. One of the first operations consists of removing the valve box. On certain types of hammers, where the handle may be removed from the barrel, a steel rod of suitable size and length is inserted into the piston bore from the nozzle end until it strikes the top of the valve box. A light tap on this rod will usually remove the box complete. Provided the valve-box cap remains in the barrel, it may be removed by striking the handle end of the barrel against a block of wood or lead. On other types of hammers, in which the valve box or guide has a tapped hole, a bolt is screwed into the opening and used as a puller to remove the box or guide from the barrel. In order to disassemble

* This is the sixth of a series of articles dealing with repair work at the P. R. R. Pitcairn (Pa.) air-brake repair shop. Other recent articles appeared in the June, September and October, 1935, issues.



General view of the pneumatic-tool repair section at Pitcairn shop

the valve box it is held upside down with the hand gripping the center. The piston end is tapped lightly until the piston and the valve box separate. Particular care must be exercised not to grip the box or cap in a vise or try to pry them apart with a screw driver or similar tool.

When the difference between the diameter of the valve and the bore of the valve block is greater than .001 in., the valve is renewed. When the valve block is broken or worn more than .009 in. larger than standard, it is renewed. Oversize valves are furnished in step sizes of .001 in. to .008 in., inclusive. The bore in the valve block, if considerably worn, is lapped in a center lathe by means of a cylindrical lapping stick, a fine grade of carborundum and oil being used. The valve is lapped to the bore by means of the same abrasive. Pistons that are worn to such an extent that the tool requires excessive air consumption or when they are shorter than standard length are considered unfit for further use.

Riveting hammer nozzles which are worn .010 in. larger than the standard bore are, in some cases, closed in by heating and swaging on a mandrel and then grinding them to the proper size for rivet sets. Another practice is to grind out to fit a .125-in. oversize rivet set. In the case of chipping hammers, when the nozzles are worn .003 in. above standard diameter they are renewed. On riveting hammers the barrels are scrapped when they are worn .006 in. over the standard bore at

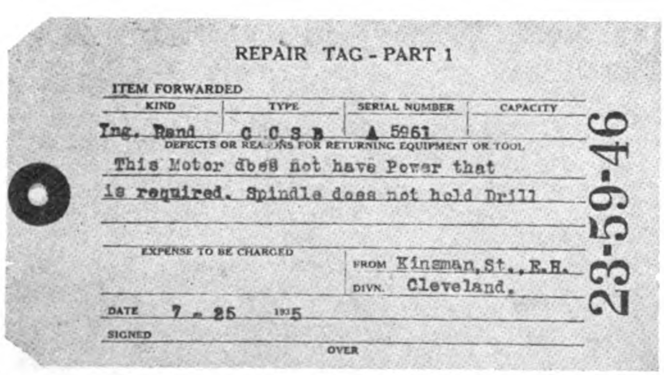
THE PENNSYLVANIA RAILROAD
REPAIR TAG - PART 1
RETURN TO

O 16
25M-8-7-34
15x3 1/6"

SHOW ABOVE THE NAME AND DESTINATION TO WHICH ARTICLE WHEN REPAIRED IS TO BE RETURNED

SHIPPER WILL USE ONE TAG FOR EACH PIECE OF EQUIPMENT OR TOOL FORWARDED

REPAIR POINT WILL USE THIS PART OF TAG IN AN S.K. 2 ENVELOPE FOR RETURNING REPAIRED ARTICLE TO CONSIGNEE



REPAIR TAG - PART 1

ITEM FORWARDED

KIND	TYPE	SERIAL NUMBER	CAPACITY
Ing. Rand	C C S B	A 5961	

DEFECTS OR REASONS FOR RETURNING EQUIPMENT OR TOOL
This Motor does not have Power that
is required. Spindle does not hold Drill

EXPENSE TO BE CHARGED
FROM Kinsman, St., E.H.
DIVN. Cleveland.
DATE 7 - 25 1935
SIGNED
OVER

23-59-46

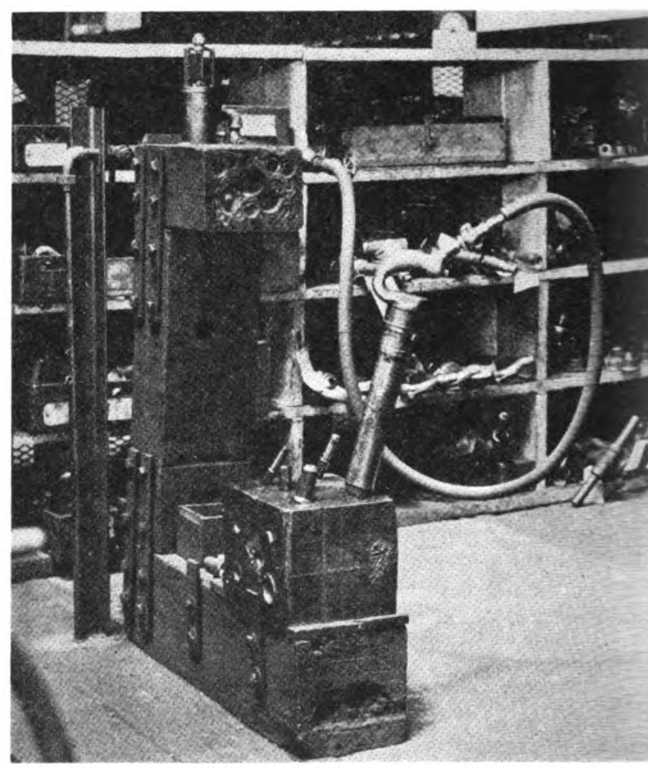
Front and reverse sides of one of the three parts of the repair tag used for shipping pneumatic tools to the central shop

the handle end. Chipping-hammer barrels are reground to the size necessary to true them up and new pistons are lapped in, although when the bore has been enlarged by grinding to such an extent that further enlargement is prohibitive, the barrel is considered unfit for further use.

The welding, by the oxy-acetylene method, of cracked barrels is practiced to a limited extent. Sometimes it becomes necessary to face the valve-block bearing in the barrel in order to aline it to the bore. This is accomplished by the use of a special reamer. On that type of hammer on which the handle is bolted to the barrel there is a ground joint between the handle and the barrel. Particular care must be exercised to see that this joint is not damaged and, if necessary, the joints are lapped on a face plate and then ground together. The bolts are pulled up evenly and tight, as the failure to do this will result in an air leak which destroys the air cushion for the piston on the return stroke, with the additional possibility that the piston striking the handle may break the bolts.

Assembling Pneumatic Hammers

When the hammer valve and guide are assembled the valve must be free in its guide. The valve is then inserted in the barrel, care being taken to see that it is free in the barrel as well. The guide is then inserted,



Device for testing the air consumption of pneumatic hammers

and, with the use of a tool known as a guide driver, the guide is driven in until it seats in the bottom. The guide driver consists of a round piece of soft steel about 4 in. long, one end of which is threaded to fit the guide and the other end is plain. As an extra precaution before applying hammer handles the practice is to shake the barrel to make sure the valve is free. On that type of hammer in which the valve box goes inside the barrel the parts are held in a horizontal position in order that the box and the cap will stay assembled when placing them in the barrel. Care is taken to make sure that the exhaust deflector is so located as to discharge the exhaust in the desired direction. Care must also be taken to insure that the lug on the deflector is in one of the notches in the barrel so as to prevent it from turning. This is done before applying the handle.

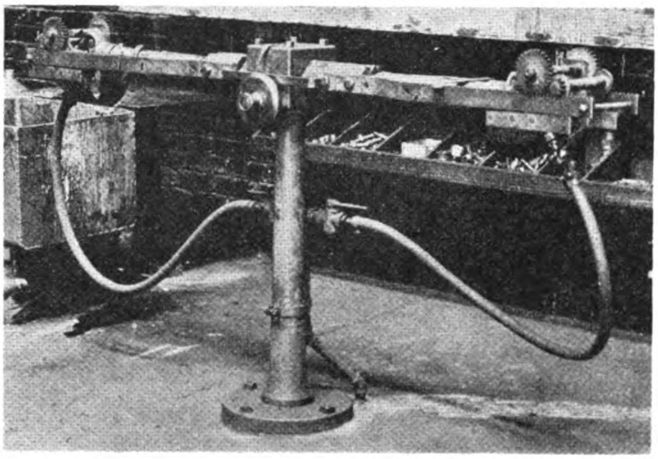
In the case of a one-piece valve box, this is assembled by placing the box on the barrel with the cupped side up and the valve on top of it. In the case of a two-piece valve box the valve seat is placed on the barrel first, then the valve, and finally the valve box with the

cupped side down. It is possible on some types to get the seat and the box upside down and, in order to prevent this, a line is cut on the edge of the seat and the box and also on the barrel so that, when assembling, these identification lines all come together.

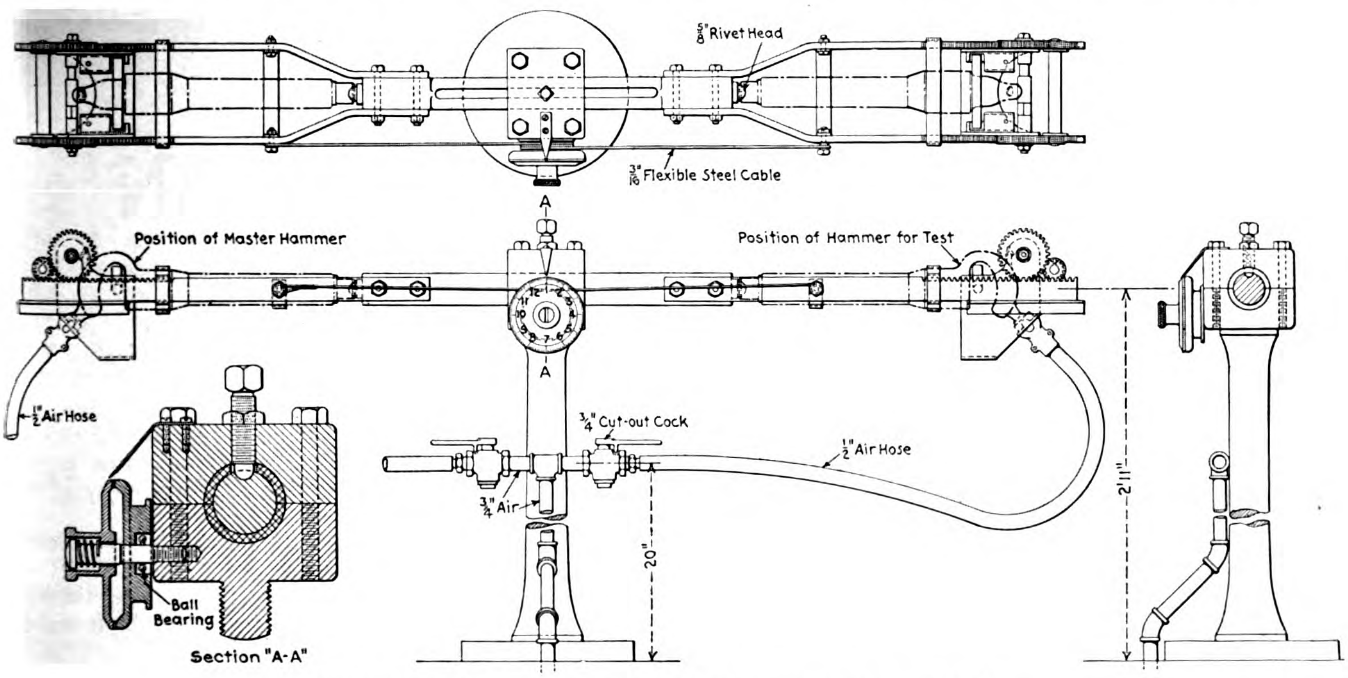
When assembling hammers equipped with the screw type handle the handle is screwed onto the barrel in such a manner that it will not disturb the valve and the box. This is accomplished by holding the barrel upright until the handle is down in the box. This prevents the valve from getting off its seat and being pinched or possibly broken. The pinch bolt is tightened in order to lock the handle.

Testing Hammers

When the repairs on pneumatic hammers have been completed they are subjected to a number of tests in order to determine the amount of air they consume, the number of blows per minute they deliver, and the power of the blow delivered. The volume of air consumed by a repaired hammer must not be more than 105 per cent of the manufacturer's rating on a new hammer of that type. The hammer is connected to a device, shown in one of the illustrations, which consists of a block against which the blows of the hammer are directed, and a meter in the air line which indicates the air consumption. Before the hammer is subjected to the tests the workman must make sure that the ports in the valve block and the handle are open. If by chance this should be restricted, the meter will show a low air consumption, which will be a false rating and not indicative of good performance. The next test is that to indicate the number of blows which the hammer delivers per minute. In making this test a hand tachometer, which is placed on the operator's shoulder, indicates the frequency of vibrations as transmitted from the hammer through the operator's arm to the tachometer. Repaired hammers must be able to deliver not less than 95 per cent of the manufacturer's rating for a new hammer of the same type. A testing machine is used to determine the power of the blow delivered by repaired hammers. This is determined by comparison with a master hammer which is known to be in first-class condition. The master hammer is placed in one side of the machine and the hammer to be tested is placed in the other side. The air is first turned on the master hammer, which, during operation, strikes the ram in the machine. The movement of the ram is retarded by a friction block in the center. As the hammer operates the ram travel is indicated in fractions of an inch on a dial on the machine. The time required to move the ram the predetermined distance is noted. This gives the performance of the master hammer, to which that of the repaired hammer is to be compared. The hammer to be tested is then subjected to the same test, the ram in this case traveling in the opposite direction without any change having been made in the fit of the ram in the friction block. The time required to move the ram an identical distance with that made during the test of the master hammer should not be more than 5 per cent greater.



Test device which compares the force of the blows of repaired hammers with a master hammer



Assembly drawing of the pneumatic-hammer testing machine

After having been subjected to these tests and passing them satisfactorily, the pneumatic hammers are boxed for shipment. Pitcairn shop, in meeting the requirements for the Central Region, repairs approximately 100 pneumatic hammers of various types each month.

Barton ripped a button off his overalls getting through the firebox door. "That beats me," the boilermaker commented, "a regular kid glove foreman!"

THE KID GLOVE FOREMAN

by

Walt Wyre

NEWS travels fast in a railroad roundhouse. The new general foreman came in on Number 10 at 3:00 p.m. Before the train got out of town, five minutes later, every man in the S. P. & W. roundhouse at Plainville knew that the man who was to take Sam Crabtree's place was in town. At 3:15 every one of them knew the foreman's name to be John L. Starkey, and that he was big as the original John L. Most of them also knew that he was wearing a derby hat, bright yellow kid gloves, and had a fallen eyebrow on his upper lip.

Starkey came right on up to the roundhouse, derby hat, kid gloves and all. He had no sooner squeezed through the door at the south end of the roundhouse than the drop-pit gang, fourteen stalls away, knew that he was on the job.

Everybody was working like a negro field-hand Saturday morning as the big foreman strolled through the roundhouse; at least every one in his sight was working. At least half of the force was watching through clear vision glasses of cab windows where they could see without being seen.

Henry Barton, the big pot-bellied boilermaker that does most of the electric welding, was in the fire-box of the 5092 welding up a crack when Starkey came in. Barton's helper, Bill Cox, was "grinding in" the fireman's seat box in the cab of the same engine and saw the foreman coming down the walkway at the front of the house.

"Hey, Barton," Cox yelled in the fire-box. "Here's the new foreman; take a look."

Barton ripped a button off his overalls getting through the firebox door. "That beats me," the boilermaker commented, "a regular kid glove foreman!"

Cox, in a hurry to spread the nickname, violated a safety rule by sliding down the grab irons from the cab. He dodged behind the engine in the next stall, out a back door, and came back in four stalls ahead of Starkey. The helper saw an engine with the cab windows closed a pretty good sign that some one was inside and didn't want to be seen. Cox wasn't disappointed; two machinists and their helpers and a coppersmith were in the cab.

"Seen the kid glove foreman?" Cox inquired casually.

The sobriquet stuck. "Kid glove foreman" he'll be

as long as he stays in Plainville.

Starkey went through the roundhouse and out to the office. A few moments later John Harris, the clerk, tacked a notice on the bulletin board: "There will be a meeting in the machine shop at 8:00 a.m. tomorrow morning. Everyone on duty at that time will arrange to be present. John L. Starkey, Gen. Foreman."

Jim Evans, roundhouse foreman, introduced Starkey to the overalled group of men. The introduction was brief: "Fellows, you all know Mr. Crabtree was transferred at his own request. This is Mr. Starkey who takes his place as general foreman."

It was evident that whatever Starkey's qualifications as a foreman might be, his ability as an orator was practically zero.

"Well, gentlemen—" the big fellow cleared his throat. His face was red as a new painted switch target, beads of perspiration dotted his wrinkled brow. "I didn't want to come out here"—that didn't sound so good—"that is, the management sent me out here to take Mr. Crabtree's place." He sighed deeply. "They made it plain that this is a tough place," Starkey swallowed his Adam's apple and continued. "Well, I can be tough, too. We got to cut down on engine failures. Everybody's got to cut in and do their part." He stood for a moment like a schoolboy trying to say a half learned recitation, and gave up. "That's all."

Evans broke the painful silence that followed by saying, "I'm sure we'll all do our best to help, Mr. Starkey," and started towards the board. The men followed.

THINGS went along pretty well the first day. The new foreman spent most of the time in the office. Next day Starkey set out to superheat the roundhouse force. He started in on the machine shop.

Machinist Jenkins was taking a cut on a valve bushing casting. He was taking a very light cut, skimming the metal.

"That a finishing cut?" Starkey asked.

"No, but—"

"No wonder the work's all behind! Here, let me show you." The general foreman stepped up to the lathe.

"But, Mr. Starkey—"

"Aw, it'll cut it, all right. Just get the tool under the surface—like this." Starkey rammed the tool an eighth of an inch in the metal. Cuttings began to fly. Henderson held a brush, used for the purpose, against the tool post to stop the flying metal.

"How long have you been doing lathe work?" Starkey asked when the cut across the casting was finished.

"Oh, about eight or nine years," Jenkins replied. "Why?"

"Well, looks like you'd a-learned something about it in that time." With that sarcastic reply the general foreman left the machine shop and went out in the roundhouse.

He stopped at the drop-pit to watch a machinist and helper, Johnson and Gibson, tramming a set of wheels on the 5075 preparatory to putting the rods on. Evidently Starkey didn't like the manner in which the work was being done, for he went over and took one end of the tram from the machinist. Johnson stood silently by, looking like a kid that furnished the bat for the ball game and then didn't get to play. Some of the surly expression left Johnson's face after he and the helper exchanged knowing glances when the boss wasn't looking. Johnson and Gibson had been working together a long time and understood each other pretty well.

After the job of tramming the wheels was finished, the foreman went down through the house. At every place he found men working, he stopped to watch. Almost invariably he found some reason to criticize the manner in which a job was being done, or to suggest a different way. His suggestions were usually good, showing that he at least knew a locomotive if he hadn't learned men. As he went through the house, he left a feeling of resentment in his wake.

He kept it up all morning, walking steadily from one job to the other. Henry Barton suggested that somebody ought to tie him up to keep him from walking himself to death.

SHORTLY after the one o'clock whistle blew, Master Mechanic Carter came to the roundhouse to see how the new general foreman was making out. Carter happened to fall in behind Starkey and probably wouldn't have caught him except for the fact that he met the foreman coming back. As he walked through the house the master mechanic couldn't help but notice the unusual activity of the place. Everybody was working like ants before a storm.

"Well, looks like you've got things humming," Carter said. "I haven't seen men working so lively since the coach shop burned down."

Starkey pushed his derby back from his forehead with a yellow gloved hand. "Yes," he replied somewhat grimly, "you know what the superintendent of motive power said. He said if I didn't make this job go I would. I'm going to do it, too, if I have to run off half the men here."

"I wouldn't try it all in one day, if I was you," the master mechanic counseled.

A laborer sweeping nearby heard the latter part of what the general foreman said. He immediately rushed out to the official broadcasting station, the shopmen's toilet, to put the latest news on the air. "The kid glove foreman is going to run half of us off the job," the laborer announced to the half dozen men in the place. With that as a starter, he elaborated on the conversation between the general foreman and master mechanic.

In the meantime, Jim Evans, having decided that two roundhouse foremen were not needed at the same time, spent the greater part of the morning in the office. Everything that was called was just about ready to go anyway, and if an extra west was needed, as expected, the 5092 would be ready to go most any time. About all that was needed to finish was the right front valve bushing and Jenkins had started on it first thing that morning.

About two o'clock the dispatcher called up for an engine for the expected extra; called for three-thirty.

"Tell him it'll be the 5092," Evans informed the clerk. "Guess I'd better go see if they got a fire in her."

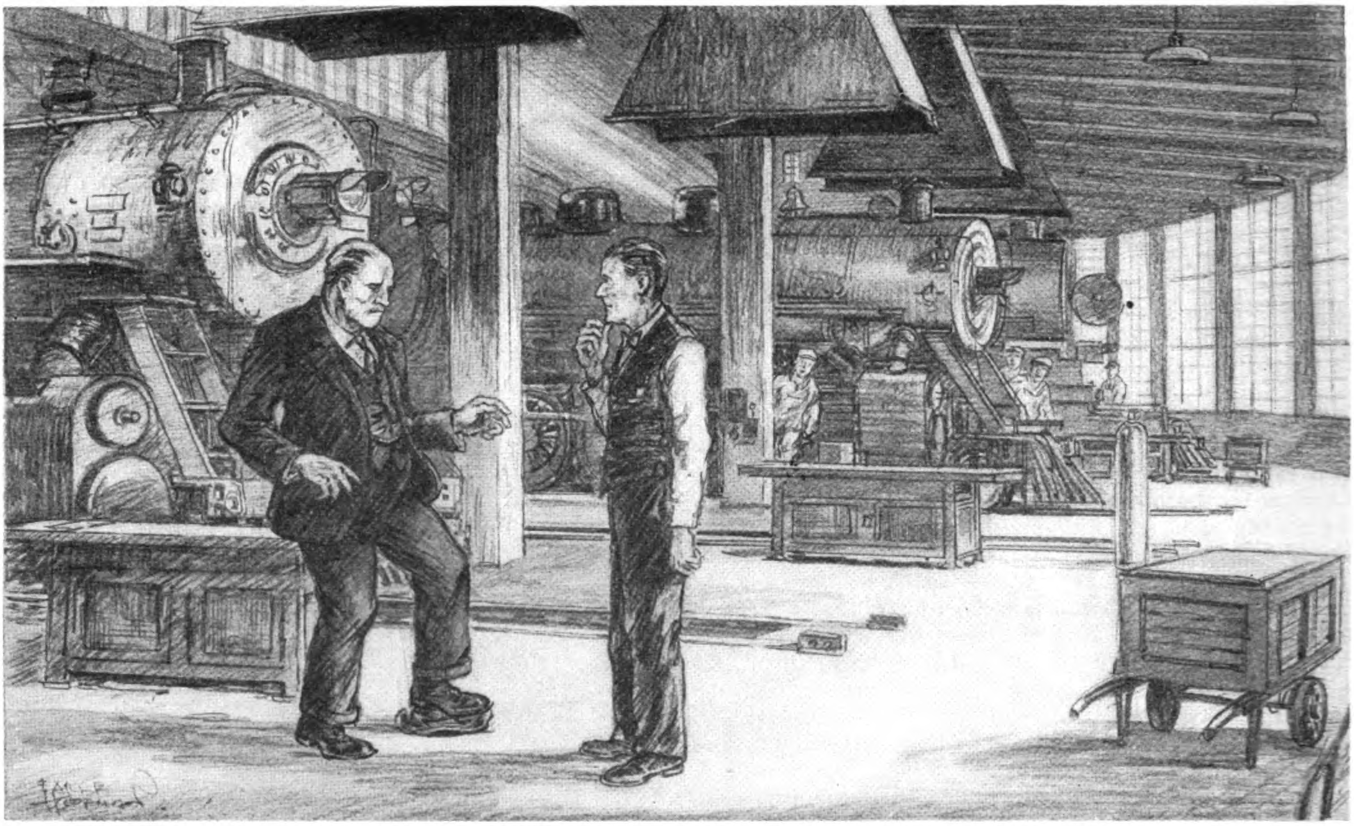
Evans sauntered leisurely out to the roundhouse and to stall twelve. The right valve piston for the 5092 was laying on a bench nearby. The right front bushing, with a jagged lengthwise gash burned in it with a carbon arc, lay on the ground. There was no bushing in the front end of the valve cylinder.

Evans, as he looked things over, absent-mindedly fished in his pocket for his plug of "horseshoe." He bit off a nickel's worth and headed for the machine shop like he was racing with his shadow.

The bushing was laying on the machine shop floor. No finishing cut had been taken on the casting. Jenkins was making a middle connection bushing.

"Why didn't you finish this valve bushing before you started on anything else?" Evans asked loud enough to be heard above the noise of the lathe.

"Well, being as it is already over a sixteenth too



Starkey jerked the derby off his head, threw the unoffending sky-piece on the ground and jumped up and down on it.

small, I didn't see any use taking any more off of it," Jenkins replied.

"Why in thunder didn't you tell me you'd killed it? How come you made a bull like that anyway?"

"Didn't; the kid g——, I mean the new general foreman was showing me how to run a lathe," Jenkins told him.

"Why didn't you get another casting?" Evans wanted to know.

"There wasn't any in the storeroom."

Evans swore almost pathetically. There wasn't another engine that could be gotten ready for the special. He found Barton and set him to work building up the casting with electric weld and went back to the office to break the news to the dispatcher that the engine on the extra would have to be run through, meaning an hour or more delay.

THREE days after Starkey came on the job as general foreman, an air of nervous tension pervaded the roundhouse. The men no longer joked and jibed at each other as they went about their work. Every one seemed to be working at top speed, but somehow the work was never done on time. Delays and failures began to pile up; engines wouldn't steam; injectors failed because of stopped up tank hose, that happened twice in as many days; hot pins, hot driving-boxes. Starkey got to the point that in addition to trying to be general foreman and roundhouse foreman he tried to inspect every engine that came in or went out. Not satisfied with all that, he occasionally jumped in and gave a hand on a rush job. The yellow kid gloves became black with grime. He threw them away in favor of a pair of leather palmed canvas ones such as the mechanics wore.

The last straw was added when the 5075 came off the drop-pit. Because of having no other engine ready, Evans took a call on her for an east-bound drag before he had a chance to limber the engine up. They had to cut the engine out at the first station twenty miles away, half the bearings on her burnt up.

Starkey was out in the roundhouse when the clerk told him about it. That was when the derby went. Starkey jerked it off his head, threw the unoffending sky-piece on the ground and jumped up and down on it. He went bareheaded the rest of the day. Next morning he wore an old soft hat to work.

The master mechanic was on hand when the 5075 was brought in. He was chewing fiercely on an unlighted cigar. "Who put this engine up?" he demanded.

"Why, Jenkins put the wheels up and the rods on, I believe," Evans replied.

"Send; get him!"

Evans soon returned with Jenkins.

"Jenkins," Carter glared, "Jenkins, I thought you were too good a mechanic to put up a job and have it fail like this."

"I thought it was O.K." the machinist replied.

"Thought it was O.K.—you're supposed to know it was O.K. Did you check the lateral on all the bushings?"

"Yes, sir."

"Are you sure they were all well greased?"

"Yes, sir."

"Well, it looks damned funny to me. Go get a tram rod. I want to see if the wheels are in tram."

"I'm certain the wheels are in tram," Starkey cut in. "I know because I checked them myself."

"Well, I'm going to check them myself. Somebody has got to explain why an engine coming right off the drop-pit burns up every rod bushing on it," the master mechanic told him.

The wheels were not in tram; in fact, they were badly out. No one but Carter and the general foreman knew what transpired in the office, but according to those claiming to know the walls of the building were seen to bulge and recede while the conversation was going on.

From that time Starkey spent more time in the office and less in the roundhouse. In fact, to keep up with the volume of correspondence that piled in, he didn't have much time for anything else.

STRANGELY enough, things began to improve in the roundhouse. Men worked with less feverish rush but seemed to accomplish more. There was, however, still a great deal of room for improvement. The strain had begun to tell on the general foreman also. His face showed tired lines, his eyes an abstracted look as though peering in the distance and seeing nothing. When the men went to him to ask him anything, which was very seldom, his replies, more often than not, were disconnected and without clear meaning. The kid glove foreman was letting the job get him down and he knew it.

About a week after the dismal failure of the 5075, he received a personal letter from the superintendent of motive power. The letter stated in effect that the superintendent of motive power had been seriously disappointed in results and unless a marked improvement could be shown immediately he had no choice but find another general foreman for the Plainville roundhouse.

While Starkey was reading the letter, the phone rang. The clerk answered it. "Hello—yes—wait just a second. O.K., go ahead slow so I can copy it."

Starkey went over to the desk and read the message as the clerk copied it in long hand. The message was addressed to J. L. S., and was: "Engine 5081, train No. 10, failed Sanford date. Broken crosshead guide yoke, badly cracked, old crack. Train delayed three hours forty minutes. Take inspector responsible out of service. Will hold formal investigation on arrival Plainville. Answer quick. H. H. C."

The initials were those of H. H. Carter, master mechanic. As Starkey read the message, his face reddened. A line of white showed on each side of his mouth.

"What'll I tell him?" the clerk asked.

"Tell him—" Starkey swallowed hard, "tell him that I'm responsible for the failure. I O.K.'d the engine and knew the guide yoke was cracked; run it anyway, didn't have another engine. The inspector showed me the crack," Starkey added.

News travels fast in a railroad roundhouse. In less than two hours every man in it knew that the general foreman had deliberately lied to save the inspector's job. Not only did they know he had deliberately lied, they knew that he had done it when his own job was hanging by a thread. Why he had done it, Starkey couldn't have told himself. All he knew was that he was tired of rawhiding men—tired of the job he had tried to make a go of and failed. He wanted to go back to the erecting floor job in the backshop where everything was routine work, no hot shot, no engine failures, just eight to five, the same old thing. He slumped wearily in a chair.

Two days later the master mechanic returned to Plainville. Fifteen minutes after he got to town, every one in the roundhouse knew it. Almost immediately an air of suppressed mystery, an intangible something about to happen, suffused the shop. Men congregated in little groups of two's and three's. Several were seen talking to the roundhouse foreman. A little later five men of different crafts in the roundhouse, machinist, boilermaker, blacksmith, coppersmith, and electrician were on their way to the master mechanic's office. The five men stayed in the office nearly an hour.

After they had left Carter called the general foreman and told him to come to the office.

"Starkey," the master mechanic began, "your showing as a general foreman has been miserable. Engine failures and delays have been terrible. Some of them absolutely inexcusable. I had intended to wire the superintendent of motive power today to ask that you be transferred immediately."

"Yes, I know. I—"

"No, I don't believe you do know, but I'm giving you another chance to learn, and I'm going to tell you something else. Five men representing the men in the roundhouse called on me a few minutes ago and asked that you stay here. Each one of those five men was willing to take the blame for the poor showing you've made. Why, I don't know, but I can tell you this much, when you can get a bunch of men feeling that way, you're a long ways towards correcting the trouble that is in the shop."

"Thanks, Mr. Carter—"

"Hell, don't thank me, thank the men. I tried to tell you the first day," Carter interrupted.

There was a notice on the bulletin board that afternoon: "There will be a meeting of roundhouse employees in the machine shop at 8:00 a.m. tomorrow morning. All employees that can arrange to do so will please be present."

"Fellows—" Starkey began, swallowed a lump and started over. "Fellows, I—I think," he stalled again. "Damn it, thank you!" A tear rolled down each cheek. "That's all," he finished gruffly.

Silence, then some one clapped, and everybody clapped. Not much had been said, but—they understood. He would still be the kid glove foreman, but the nickname had taken on a different meaning.

Ram-Type Production Turret Lathes

THE Gisholt Machine Company, Madison, Wis., is introducing an improved design of ram-type turret lathe in three sizes which are efficient both in high-production work and in small lots. These machines are easy to operate, their fast manipulation being due partly to automatic labor-saving devices built into the machines.

The hexagon turret and its stop roll are indexed automatically to the next position with the back movement of the ram slide. As the ram slide goes forward to the work the hexagon turret is located automatically and clamped in place. As the operator need not take his hands from the pilot wheel to accomplish this whole operation, it is simple to carry through the cycle of operations and without lost time.

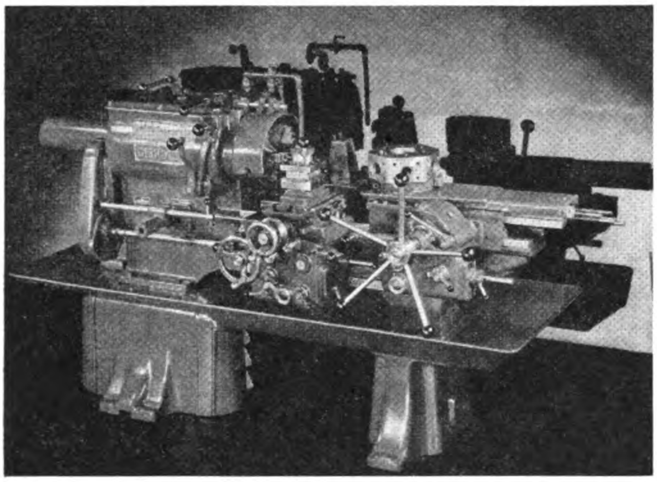
The quick-indexing square turret on the cross-slide is arranged for holding four tools. Here again a single lever movement accomplishes the indexing, locating and clamping. A forward and backward movement of the lever is all that is required to index the tool post preparatory for the next operation.

The selective gear transmission permits a change in spindle speed without passing through intermediate speeds. Three levers, simply operated and conveniently located, control the 12 speeds available. One lever splits the 12 speeds into two groups of six speeds each, one high and one low. The second lever splits the group being

used into two further groups of three speeds each. The third lever selects from this group the particular speed desired. The shift from high to low speed, as from drilling to reaming or from turning to threading, is made through multiple-disc clutches and is done without stopping the spindle. The shifting mechanism is simple and has no complicated mechanism.

A single lever controls shifting from forward to reverse. When the lever is in the neutral position a brake is applied automatically to stop the spindle. No time is lost waiting for the work to coast to a stop before being reversed. A safety latch in the neutral position prevents accidental starting.

The headstock is oiled automatically by a splash system, the gears running in a bath of oil which is carried to all bearings and moving parts at all speeds. The tapered-roller spindle bearings are continually oiled with clean filtered oil from a catch reservoir. The aprons are oiled automatically by a forced-feed system which pumps a steady stream of oil over the gears and bearings. Hand pumps are provided at the apron ends for lubricating the way, a few strokes of the pump lever being all that is required when starting the machine.



Gisholt ram-type high production turret lathe

The three new Gisholt ram-type turret lathes are identical in design and construction, differing only in size and capacity. They cover 1½-in. to 2½-in. bar capacity and 8-in. to 15-in. chucking capacity. All machines are equipped throughout with tapered roller anti-friction bearings and hardened alloy-steel gears. The ways of the turret slide, saddle and bed are hardened steel, securely attached and ground in place.

The Universal Turret Lathe

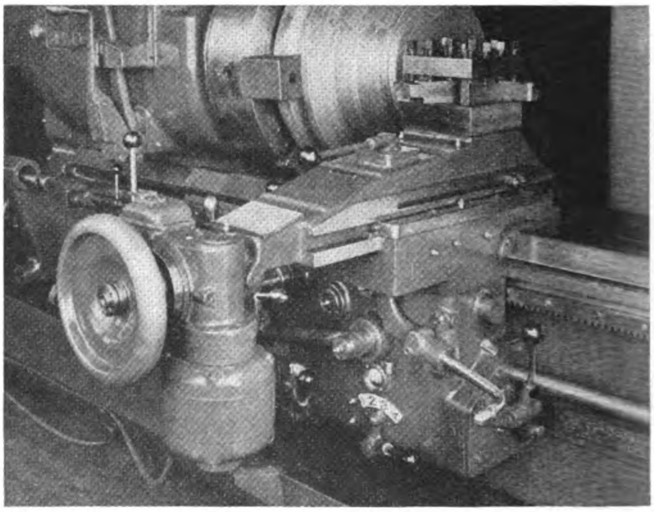
A NEW 4-A universal turret lathe is announced by the Warner & Swasey Company, Cleveland, Ohio. The machine is offered in 8-in. and 9-in. spindle capacities and 28¼-in. swing. The spindle is mounted on Timken bearings at the spindle nose end and on straight-roller bearings at the rear. All shafts of the head are mounted one above the other to the rear of the spindle, thus placing the rear train entirely to the rear. This construction promotes rigidity and permits a larger spindle.

The bed section reaches down almost to the chip pan, passage for chips being provided in arched holes under the rear way of the bed. A new cross slide and square turret offer rigidity featured by a square lock gib, used for the first time in combination with the conventional dovetail on the opposite side of the cross slide. This construction offers increased capacity for absorbing the strains in overhanging tools; it supports the heaviest cuts taken by carbide cutters without vibration. Hard steel replaceable wear strips have been added to the seat of the cross slide to further preserve initial accuracy.

The square turret has an internal-circumference clamp ring which eliminates the tendency at this point for looseness due to excessive wear. The indexing clamp handle is located in front where it overcomes interference with hexagon-turret tools when indexing, which construction permits indexing in tight positions. As optional equipment, an open-type square turret can be furnished which permits multiple tooling and the holding of long-shank forming tools. Conventional rockers are replaced by shims to elevate the cutting tool to the correct height, a construction essential on carbide tools to insure correct cutting angle after cutter regrinds.

Both hexagon-turret slide and square-turret carriage are equipped with an oil reservoir and a Bijur pump. The pump is actuated by the travel of the slide and automatically lubricates the ways whenever the slide moves. The oil reservoir being a glass chamber and separate from the apron mechanism is sealed against coolant. The ways are protected by patented covers.

A direct-reading indicator is found in the head-gear shift which affords increased ease of operation and enables the operator readily to pick the desired spindle speed without referring to diagrams or charts. Rapid traverse is offered as optional equipment for the cross slide. For certain chucking operations where frequent in-and-out movement is necessary, this is a definite time saver. This is provided through an electric unit mounted in front of the handwheel and equipped with a built-in switch. Large contacts permit quick and effortless control of the cross slide in either direction. The cross-slide handwheel is of heat-treated aluminum alloy to reduce momentum.



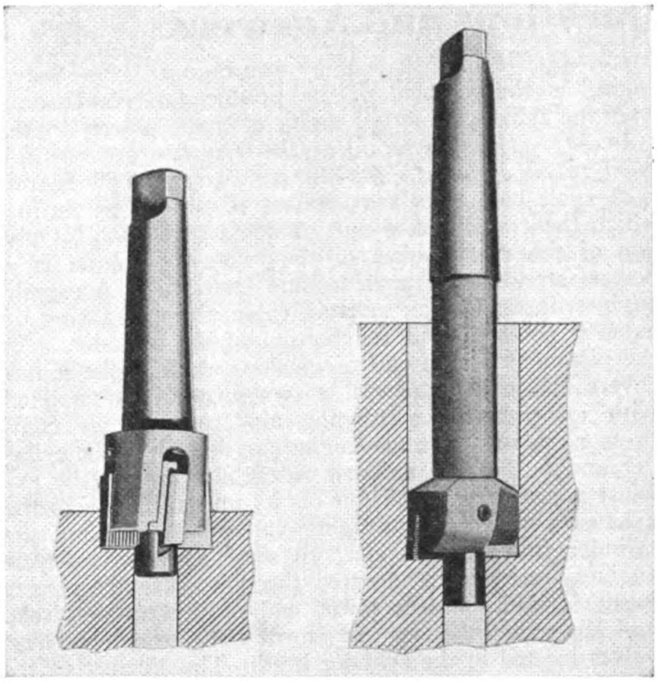
Increased life and convenience of operation are embodied in new Warner & Swasey universal turret lathe

An independent lead screw is an important feature for threading operations. A solid lead screw is provided which is independent of the feed shaft. This screw is used for threading purposes only while all feed and rapid

traverse functions operate through the usual rack and pinion. By this means the accuracy of the lead screw is preserved throughout the life of the machines. Pick-off gears are provided which are changed to provide the desired pitch of thread. A feature of this unit is the quick return of the carriage at a constant speed of 5 ft. per min., independent of spindle speed and accomplished through a convenient lever on the apron without reversing or stopping the spindle.

Zee Lock Counterbores

THE Ingersoll Milling Machine Company, Rockford, Ill., has extended the application of inserted Zee-lock cutter blades to counterbores. Two designs are offered—one of the shallow type used for shallow boring or spot-facing operations, and another for deep boring operations. Both incorporate the Ingersoll Zee-lock cutter blade which is positively locked and adjustable in two directions. Furthermore, the serrations are broached into the cutter housing so that by moving the cutter blade to the next slot in sequence it



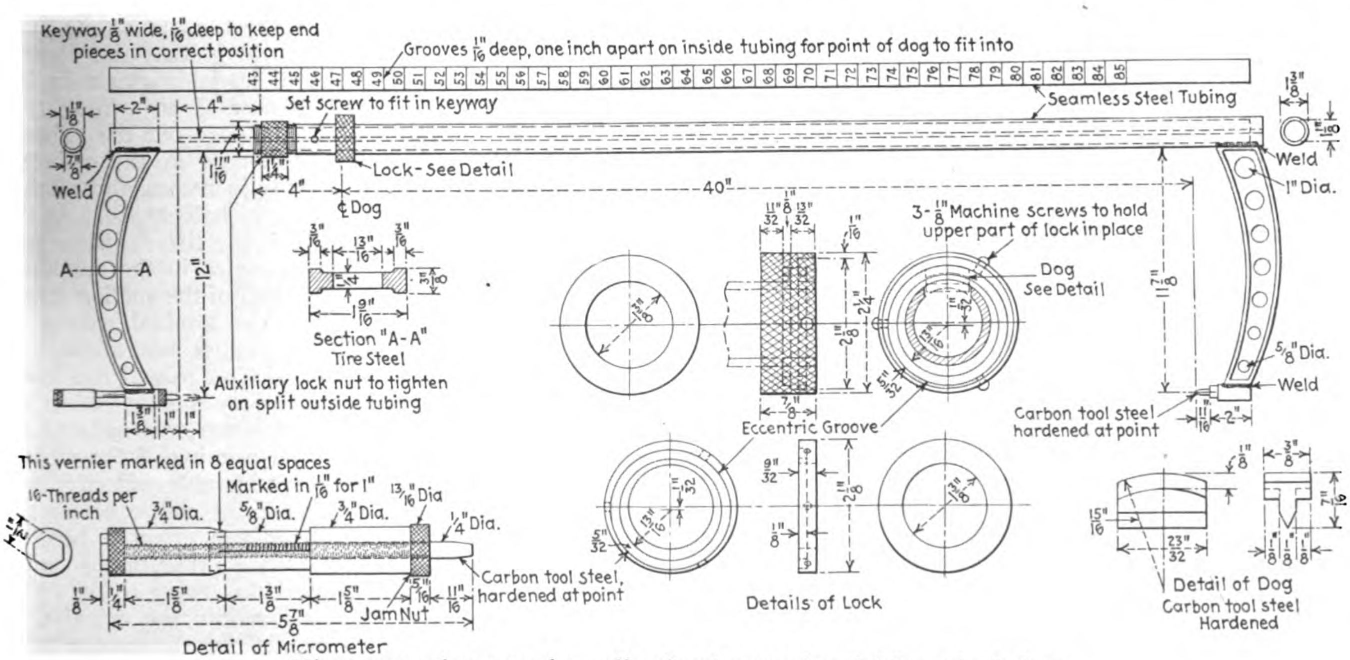
Counterborer with Ingersoll zee-lock cutter blades

Light Compact Tire Gage Gives Accurate Readings

A SHOP-MADE micrometer tire gage, developed and used successfully for some time at the Moberly, Mo., shops of the Wabash, is shown in the drawing. The gage is compact and light, weighing only 15 lb. It has long ranges due to the telescoping feature, is conveniently handled and gives unusually accurate readings. It can be used to caliper any tire or other part from 44 in. to 86 in., and give the exact size to $\frac{1}{128}$ in.

The gage is made to read in sixty-fourths instead of thousandths, as the average railroad mechanic works to these dimensions instead of thousandths. This gage will give the exact size of any object calipered without recourse to rule or tape line, which is necessary on ordinary tire calipers. For example, if necessary to order a tire for a locomotive to match other tires, the opposite tire is calipered and a reading of the gage shows the size to order, while with ordinary tire calipers it is necessary to measure between points, and if the long scale used is defective, which is often the case, the tire, when received, will be either too small or too large.

This gage is also a great help in turning tires accurately. The reading of the vernier shows the exact amount necessary to take off each tire to make all of the same size. The detailed construction of the gage is quite clearly shown in the drawing.



Micrometer tire gage for calipering locomotive driving wheel tires

is moved out only part of a serration. The diameter is thus maintained with a minimum of grinding.

The shallow counterbore which has four serrated blades interlocked with a hardened and ground pilot is used for counterboring where the depth of the hole is less than one half the diameter. The deep counterbore has two husky adjustable serrated blades and a body well relieved for generous chip allowance, so that holes of great depth may be counterbored, or previously drilled holes enlarged.

Diesel Engine Questions and Answers

13.—*Q.—What is meant by scavenging?* A.—Scavenging is the removal of the products of combustion from the cylinder of an oil engine after the power stroke.

14.—*Q.—What is meant by the term two-cycle as applied to oil engines?* A.—In the two-cycle oil engine each cycle comprises two strokes of the piston during which the crank makes one complete revolution. Only one of the two strokes of the two-cycle engine is a power stroke. In marine and stationary two-cycle engines, instead of an exhaust valve, there is a ring of exhaust ports around the bottom of the cylinder. As the piston nears the end of its downward stroke it uncovers the exhaust ports, scavenging valves supplied with low-pressure scavenging air from an air compressor open and the scavenging air flows into the cylinder and pushes the exhaust gases out through the exhaust ports. As the piston on its up-stroke covers the exhaust ports, the scavenging valves close leaving the cylinder full of fresh air. In some railway two-cycle engines fresh air is admitted through scavenging ports in the cylinder at the lower end of the piston stroke and the exhaust gases are blown out through exhaust valves located in the cylinder head. The exhaust valves are actuated by a cam shaft and open approximately 30 deg. of crank rotation before the scavenging ports are uncovered. The exhaust valves remain open while these ports are uncovered. On its upward or compression stroke the piston compresses the air in the cylinder and as it nears the top of its stroke fuel is injected which is ignited by the high temperature of the compressed air in the cylinder, the gases burning and expanding and pushing the piston down on its working stroke.

15.—*Q.—What is meant by the term four-cycle as applied to oil engines?* A.—In a four-cycle oil engine one complete cycle of operation requires four strokes of the piston, the crank making two complete revolutions during the cycle. In only one of the four strokes does the piston receive a turning impulse from the expanding gases in the cylinder. Assuming the piston to be at the top of its stroke with the air inlet valve open and the exhaust valve and fuel valve closed, the piston draws air into the cylinder during its down stroke. As the piston reaches the end of the suction stroke the air-inlet valve closes and as the piston rises on the second or compression stroke the air in the cylinder is compressed to about 450 lb. per sq. in., as the result of which its temperature increases to about 1,000 deg. F. The fuel injection valve now opens and the oil is sprayed into the cylinder at high pressure. The high-temperature of the compressed air in the cylinder ignites the fuel and it continues to burn as long as injection is maintained. Combustion of the fuel raises the temperature of the gas to approximately 3,000 deg. F. In the meantime the piston has started down on the third or expansion stroke with the gas expanding behind it. The injection valve closes shortly after the piston has started down on this stroke. At the end of this stroke the exhaust valve opens and the burned gases in the cylinder, now reduced to about 40 lb. per sq. in. pressure and correspondingly reduced in temperature, start to flow out through the exhaust pipe. As the piston rises on the fourth or exhaust stroke it pushes the remaining gas out of the cylinder. At the end of this stroke the exhaust valve closes, the air inlet valve then opens and the cycle of operation starts over again.

16.—*Q.—Explain the cycle of operation of a four-cycle Diesel engine, both solid-injection and air-injection.* A.—The main features of the cycle are the same whether solid-injection or air-injection is used. With air-injection, compressed air at 800-900 lb. per sq. in. forces the fuel through the atomizers or spray valves into the cylinders. With solid-injection this is done by the pressure of the fuel-oil pump. In the four-stroke cycle, on the first down stroke air is drawn into the cylinder from the atmosphere through the air inlet valve. On the up stroke this air is compressed by the piston to approximately 450 lb. pressure and 1,000 deg. F. Just before the end of the stroke the fuel is injected; this, mixing with the heated air, ignites and combustion is started. The third stroke is the working stroke. Combustion continues until the fuel is consumed. The fuel is cut off at about 0.1 stroke. Expansion of the gases generated by combustion drives the piston down till near the end of the stroke, when the exhaust valve opens and the burnt gases are released. During the fourth stroke the remaining exhaust gases are expelled through the exhaust valve, after which the cycle of operation is repeated.

17.—*Q.—What is the true Diesel principle?* A.—(a) Compression sufficient to produce the temperature requisite for the spontaneous combustion of the fuel. (b) Injection of the fuel by pressure or a blast of compressed air. (c) A maximum cycle pressure (attained during combustion) not greatly exceeding the compression pressure, and absence of pronounced explosive effect.

18.—*Q.—Describe the suction stroke of a Diesel engine.* A.—If the engine is considered to be at its top dead center, and just about to begin the suction stroke, the suction valve is already slightly open. At the same time the exhaust valve, which has previously closed during the exhaust stroke, has not yet come on its seat. The result of this state of affairs is that the rapidly moving exhaust gases create a partial vacuum in the combustion space and induce a flow of air through the suction valve, thus tending to scavenge out the exhaust gases, which would otherwise remain in the cylinder. As the piston descends, its velocity increases, and reaches a maximum in the neighborhood of half stroke. At the same time the suction valve is being lifted off its seat and attains its maximum opening also in the neighborhood of half stroke. The lower half of the suction stroke is accompanied by a more or less gradual closing of the suction valve, which, however, is not allowed to come on its seat, until the crank has passed the lower dead center, by about 20 deg. At the moment when the crank is passing the lower dead center, the induced air is passing through the restricted opening of the rapidly closing suction valve, with considerable velocity, and an appreciable duration of time must elapse before the upward movement of the piston can effect a reversal of the direction of the flow through the suction valve. It will be clear from the above that, owing to the effect of inertia, more air will be taken into the cylinder, in the manner described, than by allowing the suction valve to come on its seat exactly at the bottom dead center.

NEWS

The United Carbon Company has ordered 10 covered hopper cars from the American Car and Foundry Company.

The Pennsylvania has ordered 10,000 sets of AB brake equipments from the Westinghouse Air Brake Company.

The Atchison, Topeka & Santa Fe is inquiring for 500 box cars of 50 tons' capacity and 50 hopper cars of 70 tons' capacity.

The National of Mexico has placed orders for Coffin feedwater heater systems, totaling 39 equipments, with the J. S. Coffin, Jr., Company, Englewood, N. J., through its foreign representative, the International Railway Supply Company, New York.

The Peoria & Pekin Union has ordered one Diesel-electric switching locomotive from the American Locomotive Company. This locomotive will be equipped with General Electric electrical equipment and McIntosh & Seymour power plant.

The Canadian Pacific has ordered from Fafnir Bearings Incorporated, New Britain, Conn., roller bearing journal boxes to equip eight coaches. Fafnir bearings have recently been placed on two tenders of New York Central Hudson type engines.

Union Pacific Orders Two More "Streamliners"

Two more streamline trains have been ordered by the Union Pacific from the Pullman Standard Car Manufacturing Company. They will be placed in service between Chicago and Denver, Colo., in June on a schedule of 16 hours for the 1,048 miles via the Chicago & North Western and Union Pacific, effecting a saving of a business day or nine hours as compared with the present fastest schedule, 25 hr. 15 min. eastbound. They will be the fastest trains in the world for distances of 805 miles or more, the average for the 1,048 miles being 65.5 miles an hour, including stops. Between Omaha and Denver they will be the fastest for distances greater than 360 miles.

The proposed schedule between Chicago and Denver calls for 8 hr. for the 488 miles over the Chicago & North Western from Chicago to Omaha, Neb., an average of 61 m.p.h., and 8 hr. for the 560 miles over the Union Pacific from Omaha to Denver, an average of 70 m.p.h.

The new trains, to be known as "Streamliners—City of Denver," will leave Chicago and Denver every day in late afternoon, arriving at the terminals the following morning, arrival and departure at Chicago being arranged to allow ample time for passengers to make connections with eastern trains. No extra fare is contemplated and low cost individual tray-meal service will be available in addition to regular dining-car service.

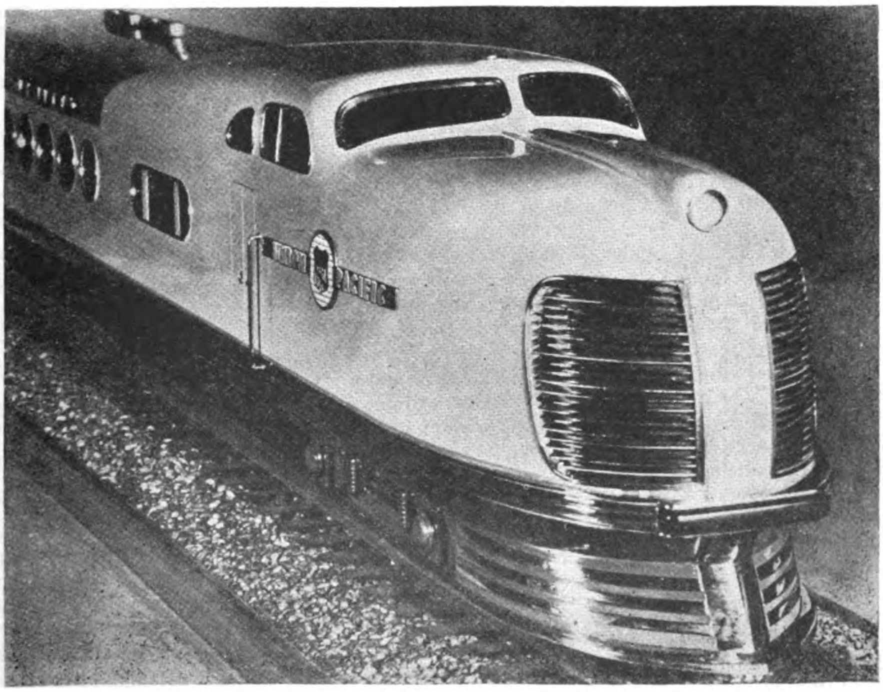
Each train will consist of a 2,400-hp. tandem power unit and 10 cars, including three Pullman sleeping cars, a Pullman room and observation car, a dining car, two coaches, equipped with adjustable, reclining seats, and three cars for baggage, mail and express. Each section of the power unit will contain an Electro-Motive Corporation 1,200-hp. Diesel engine, directly connected to generators, which will provide current for electric motors on each truck of the power cars. Each of the tandem power units will be so arranged that both engines or either individually can be operated from the controls in the cab of the first unit. The overall length of the trains will be 858 ft. and the total weight about 600 tons. Passenger capacity will be 82 in the Pullman cars and 100 in the coaches, or a total of 182. Externally the passenger-carrying cars will be of standard width, but the interior, by reason of the type of design, will be five in. wider than present standard cars and of same height.

The power cars will be built of Cor-Ten steel furnished by the United States Steel Corporation, while the principal structural material of the other cars will be aluminum alloy, except that the trucks, complete, and couplings between cars, will be steel. The aluminum alloy used will be furnished by the Aluminum Company of America.

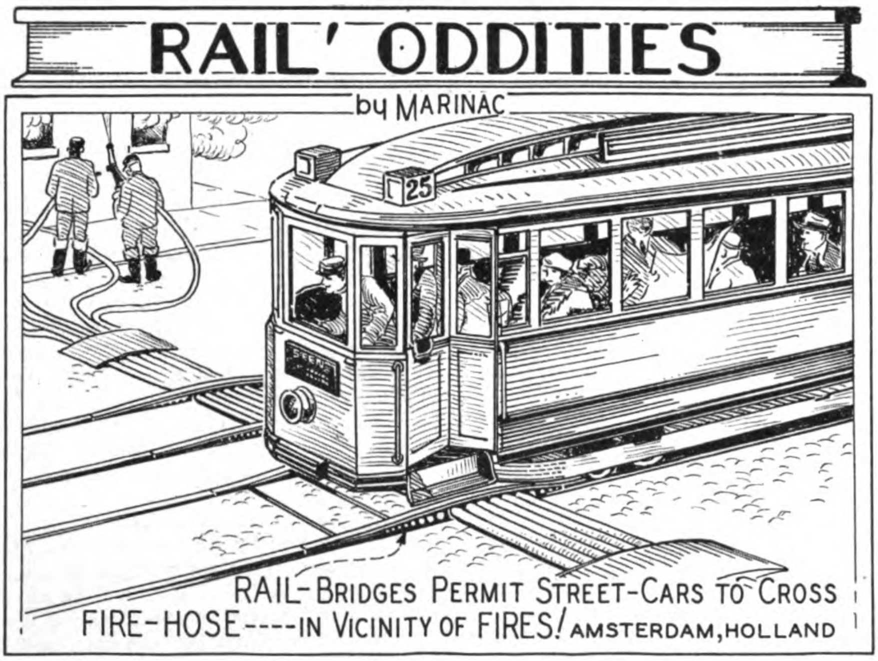
These two additional streamliners when completed will give the Union Pacific a fleet of six such trains—two for service between Chicago and Denver, one between Chicago and Portland, Ore.—two between Chicago and San Francisco, Calif., and Los Angeles, and one between Kansas City, Mo., and Salina, Kan.

Air-Conditioning Study Authorized by A. A. R. Board

A thorough study of the various systems now in use by the railroads for the air-conditioning of passenger cars is to be made by the Association of American Railroads, J. J. Pelley, president of that Association, has announced. Under au-



Both or each power unit of the Union Pacific "Streamliners — City of Denver" can be controlled from the cab in the leading car.



For explanation see page 44

thority of the board of directors, the study will be conducted under the direction of L. W. Wallace, director of the Equipment Research Division.

While practically all the principal railroads of this country, as well as the Pullman Company, are making use of air-conditioning devices for passenger equipment, the systems vary, and it is the purpose of this study to determine the relative efficiency and economy of the various types and whether the air conditions being obtained in the cars are satisfactory from the standpoint of the comfort and well-being of the passengers. At the present time there are three basic types of air-conditioning equipment being used by the railroads, although there are numerous variations of each type. The three basic types are ice, steam and mechanical compressor, in the first two of which water is used as the refrigerant. In the compressor type, however, certain kinds of gas are used as the refrigerant.

"Air conditioning of passenger equipment," said Mr. Pelley, "is of such fundamental importance to American railroads and is such a new development so far as the rail carriers are concerned that the board of directors has determined on a comprehensive research program being conducted into that subject. What the railroads want to know is what type or types are best adapted for railroad use, whether there are any improvements that can be made, which type provides the greatest comfort to the public, and which are the most economical to install and operate. Railroad managements also want to know whether some system or systems can be developed in the light of experience which the railroads have had in recent years whereby some standardization can be brought about whereby the cost of installation and upkeep can be reduced.

"Air conditioning of passenger cars is recognized by the railroads as an improvement that will eventually be in common use on railroads throughout the country. In view of the fact that in recent years the railroads have had an opportunity to experiment with and make use of various systems from a practical standpoint, the board of directors feels that a complete study at this time should bring about the development of a still greater improvement in air conditioning of passenger cars."

Santa Fe Budget

DIRECTORS of the Atchison, Topeka & Santa Fe have approved a budget for 1936 providing for the expenditure of $28,408,-973. Among the major items are the following:

500 50-ton single sheathed box cars	$1,250,000
50 70-ton hopper cars	150,000
Car improvements	1,449,665
Locomotive improvements	220,294
Topeka shops	139,118
Shop buildings, enginehouses and appurtenances	164,342
Shop machinery and tools	161,758

"Firemen" To Be Employed on "Zephyrs"

A STRIKE of 1,500 members of the Brotherhood of Locomotive Firemen and Enginemen on the Chicago, Burlington & Quincy, scheduled to take place on December 9 at 6 p.m., was averted on December 8, after a conference attended by Judge James W. Carmalt of the National Railway Mediation Board; L. O. Murdock, assistant to the executive vice-president, and W. F. Thiehoff and J. H. Aydelotte, general managers of the Burlington; and M. Larson, general chairman, and J. P. Farrell, vice-president of the firemen's brotherhood. As a result of the agreement reached, a helper will be employed to assist the engineman on Diesel-electric streamline passenger trains and the brotherhood will not insist that a helper be employed on Diesel switching locomotives.

In this controversy, the brotherhood demanded that the railroad employ a fireman in addition to an engineman on both Diesel-electric trains and Diesel-electric switchers, contending that the employment of two men was essential to safety. The management held that employee and public safety was not jeopardized when such locomotives were operated by one man and that, by calling a strike, the brotherhood was trying to evade the contract which provides for a 30 days' notice for changes in present agreements.

On December 3 the Brotherhood notified the railroad that a majority of its 1,500 members were in favor of a strike, and asked for another conference with the management. This conference took place on the following day and when the railroad would not waive its rights under the Railway Labor Act, the Brotherhood set the date for the walkout at 6 p.m. on December 9. Shortly after the strike call was issued, Dr. William Leiserson, chairman of the National Mediation Board in Washington, telegraphed Ralph Budd, president of the railroad, urging mediation of the controversy. Mr. Budd interpreted the message of the chairman to mean that the Brotherhood wished to change existing agreements which, in accordance with established custom, opened existing schedules for consideration of such other changes as may be submitted by the road.

On December 8 both parties agreed to waive their rights and the Brotherhood agreed to withhold its demands for enginemen on switching locomotives. The management felt that, while its streamline trains are safe when operated with one man, it would not contest the employment of a helper because of its high regard for safety and in view of the doubt already created in the mind of the traveling public through the publicity given the matter.

Milwaukee Repairs Back to Normal Schedule

FOR the first time since 1931, the Milwaukee, Wis., shops of the Chicago, Milwaukee, St. Paul & Pacific on December 5 resumed their normal freight and passenger car repair schedule which calls for the repair of all passenger equipment during a two-year cycle and all freight equipment on a four-year cycle. As a result, 1,200 men will be employed on a 40-hr. week to repair 2 passenger and 20 freight cars a day.

Retirement Board Seeking Registration of Furloughed Employees

THE Railroad Retirement Board, charged with the administration of the railroad retirement act of 1935, has initiated steps to secure the registration of all persons who had an employment relation to a carrier on August 29, 1935. The act describes three classes of employees who are eligible for its benefits: First, those who were in active service on or after the date the law was enacted, August 29, 1935; second, official representatives of railroad employee organizations, who qualify under stated requirements; and third, persons who on August 29, 1935, were in an employment relation to a carrier, i. e., employees who were not actually in service on or since that date but who were on furlough or leave of absence, subject to call for serv-

ice and ready and willing to serve, in accord with the rules and practices of railroad employment. It is this third class which the board wishes to register at this time; other registrations will follow later.

In order to secure data concerning the class of persons having an employment relation to a carrier, but who have not been in active service since the date of the enactment, the board is broadcasting a notice calling upon each such person to send in his name and address to the board in order that the board may forward to him forms on which registration may be made. Some of the persons who have an employment relation but are not now in active service may be eligible to receive an annuity as soon as annuity payments become due and payable, 90 days after the effective date of the act, which is March 1, 1936.

Westinghouse Fiftieth Anniversary Celebrated on January 8

The year 1936 is a "golden jubilee" year for Westinghouse, January 8 having been the fiftieth anniversary of the founding of that company by George Westinghouse on January 8, 1886, when the charter was granted to the Westinghouse Electric Company.

In commemoration of its fiftieth birthday Westinghouse, on the night of January 8, held a "family" gathering in Pittsburgh, Pa., for the 12,000 employes in that district. Simultaneously a similar meeting of Westinghouse employees was held in every important Westinghouse factory and office in the country.

A unique feature of this "family" gathering of 40,000 employes was that the complete Pittsburgh program was broadcast to all of the other meetings in plants and districts over Westinghouse's own short wave transmitter at W8XK. The program was sent out simultaneously at two wave lengths, 25.26 and 48.83 meters, and was picked up in plants and offices all over the United States and also in foreign countries.

At Pittsburgh the speakers reviewed the important contributions that Westinghouse has made to the progress of industry and to the welfare of humanity and presented a forecast of the future of the electrical industry. A Westinghouse institutional sound picture, "The New Frontiers," prepared especially for its golden jubilee, was shown to employees for the first time on this occasion. Music was furnished by Westinghouse's own organizations—the Westinghouse Band, the Westinghouse Chorus and the Westinghouse Kilty Band.

As far as is known this was the first mass gathering of all employes of a company throughout the world by means of short wave radio over its own station.

Diesel Engine Fire Caused By Fuel Tank Overflow

Following an investigation, it was determined that the fire which occurred on the forward unit of the 3,600-hp. Diesel-electric locomotive hauling the Santa Fe "Super-Chief" on a test run between Chicago and Los Angeles, Cal., as reported in the December *Railway Mechanical Engineer,* was caused by the combustion of vaporized fuel oil accidentally introduced into the engineroom and ignited by one of several means not definitely determined. An excessive amount of fuel oil was transferred from special reserve tanks in a baggage car to fuel supply tanks on the locomotive, this excess oil overflowing through vent pipes in the locomotive roof and dropping into the engine-room where it was vaporized and mixed with air from the powerful ventilating fans. The fire was limited to the engine-room of one unit of the locomotive. Only one of the 900-hp. Diesel engines was damaged and that superficially, as the fire was quickly extinguished. The main generators were not affected, but considerable damage was done to electrical connections and fittings on the interior of the engine-room, also to thin steel sections such as the side sheathing. This type of fire would not occur in normal Diesel-locomotive operation, as the provision of a reserve fuel supply on the Santa Fe test train was necessitated only by the lack of intermediate refueling facilities which will be provided when the "Super-Chief" is placed in regular service.

For explanation see page 44

Pennsylvania Orders 10,000 Freight Cars; 4,000 from Builders

The Pennsylvania has ordered 10,000 new freight cars—6,000 from its own shops and 4,000 from outside builders. The program, work on which will be got under way as soon as practicable, will involve an expenditure of approximately $25,000,000; it is called "one of the most important and extensive equipment building programs ever undertaken in the road's history."

Included in the orders are 4,700 standard steel box cars, 3,000 automobile cars, 2,000 mill type gondolas of an entirely new design and 300 hopper cars, designed especially for the handling of cement and similar commodities in bulk. Only box cars have been ordered from outside builders, while the P. R. R. shops will also build 700 of these in addition to all those of other types.

The orders were distributed as follows:

Builder and plant	No. of Cars
P. R. R. Shops, Altoona, Pa.	3,300
P. R. R. Shops, Enola, Pa.	1,350
P. R. R. Shops, Pitcairn, Pa.	1,350
Pressed Steel Car Co., McKees Rocks, Pa.	1,000
American Car and Foundry Company, Berwick, Pa.	800
Pullman-Standard Car Manufacturing Co., Butler, Pa.	700
Bethlehem Steel Co., Johnstown, Pa.	600
General American Car Co., East Chicago, Ind.	400
Greenville Steel Car Co., Greenville, Pa.	250
Ralston Steel Car Co., Columbus ,Ohio	250

The 3,000 new automobile cars have been designed in co-operation with the automotive industry to meet its latest requirements. Included will be 2,000 50-ton automobile box cars, 300 of which will be equipped with loading devices. These will be 40 ft. 6 in. long, 10 ft. 5 in. high and 9 ft. 2 in. wide, with double side doors. There will be also 1,000 50-ton auto cars, 50 ft. 6 in. in length, with double side doors, especially designed not only for automobiles but also for the movement of automobile accessories and other materials light in weight but requiring an especially long car body. End doors will be provided in 300 of these cars. The 4,700 box cars will be of 50 tons' capacity, 40 ft. 6 in. long, 10 ft. high and 9 ft. 2 in. wide, with single side doors. The gondolas are to be of 70 tons' capacity, 52 ft. long, 9 ft. 6 in. wide and with sides 3 ft. 6 in. high; they will be designed especially for the handling of long structural shapes and other mill products. The covered hoppers will be of 70 tons' capacity.

The program is expected to provide approximately 11,000,000 man-hours of work in equipment company and railroad shops,

both in the fabrication of cars and in the production of materials necessary for their construction. It is estimated that in the work of fabrication alone, employment for a full year will be given to 2,000 men. An additional 6,000 men will be engaged over a long period in the basic industries, producing various materials. The job is expected to be completed in approximately a year.

Streamline Train for N. Y. C. Cleveland-Detroit Run

The New York Central is constructing in its own shops a streamline steam train which will be placed in service next spring between Cleveland, Ohio, and Detroit, Mich., via Toledo, on a round-trip daily schedule of approximately a mile a minute, an hour faster than present schedules, for the 164.2 miles each way.

The new train, air-conditioned throughout, will consist of seven cars, embodying "every device for safety and comfort." The cars are being built in the road's car shops at Indianapolis, Ind., while the locomotive is under construction at its West Albany (N. Y.) shops. The latter will be a high-speed Pacific type and its design will differ considerably from those of the New York Central's first streamline steam locomotive, the Commodore Vanderbilt, which now hauls the Twentieth Century Limited between Toledo and Chicago; it will have roller bearings on truck, trailer and tender axles.

The train will not be articulated, but will consist of a combination baggage car, two coaches, a dining car, providing full dining facilities, a lounge-bar car, and Pullman parlor and observation cars. In each car will be embodied a number of changes from the ordinary floor plan. All cars will be of steel, but with substantial weight reductions compared with standard equipment. No name for the new train has yet been selected.

Supply Trade Notes

The Armspear Manufacturing Company has moved its office from 250 West Fifty-fourth street to 1270 Sixth avenue, New York City.

John S. Gregg, formerly of the Moise Steel Company, Milwaukee, Wis., has been appointed to the sales staff of the Milwaukee office of the Inland Steel Company.

B. H. Whiting has been appointed district manager of the Whiting Corporation, with headquarters at Cincinnati, Ohio.

The Gould Storage Battery Corporation has moved its eastern sales and service depot from 796 Tenth avenue to 549 West Fifty-second street, New York City.

J. S. Hagan has recently been appointed a railway sales representative of The Edison Storage Battery Division of Thomas A. Edison, Inc., with headquarters at Chicago.

The Republic Steel Corporation has moved its Cleveland, Ohio, district sales office from Union Trust building to 920 Republic building. W. E. Collier continues in charge of the office as district sales manager.

E. C. Roberts has been appointed vice-president in charge of sales of the Detroit Graphite Company, Detroit, Mich. Mr. Roberts was associated with Detroit Graphite Company for 16 years prior to May, 1933, when he resigned as vice-president in charge of sales, and became associated with Arco Company at Cleveland in a similar capacity.

Ervin J. Sanne, representative of Joseph T. Ryerson & Son, Inc., Chicago, has been appointed district sales manager of the Inland Steel Company, with headquarters at St. Paul, Minn.

The Bethlehem Steel Company is now conducting the business formerly conducted by three Bethlehem Steel Corporation subsidiaries—the McClintic-Marshall Corporation, the Pacific Coast Steel Corporation and the Kalman Steel Corporation.

David C. Arthurs has been elected president, and Stanley W. Butler, a member of the board of the Mt. Vernon Car Manufacturing Company, Mt. Vernon, Ill., to succeed Ralph K. Weber, who has resigned as president and a director to enter the employ of the Mt. Vernon Car Manufacturing Company.

C. A. Cherry, who has been appointed district sales manager of the Republic Steel Corporation with headquarters at Buffalo, N. Y., is a graduate of the Johnstown, Pa., high school. After graduation, he became connected with the Cambria Steel Company in the Wire Sales division. In 1917 when this company merged to form the Midvale-Cambria Steel Company, he served in the Philadelphia office of the new organization, the following year becoming private secretary to W. H. Donner, head of the Donner Steel Company. Shortly afterwards he was appointed assistant vice-president in charge of sales of that company, and in 1930 when the Donner Steel Company became a part of the Republic Steel Corporation, he became assistant manager of sales, Carbon Bar division.

B. C. Wilkerson has been appointed service engineer of the Superheater Company. Mr. Wilkerson, whose headquarters will be at New York, will service Elesco equipment on railroads in the New England territory. For many years Mr. Wilkerson was a locomotive engineer on the New York, New Haven & Hartford. Leaving the railroad he became service engineer and then chief service engineer of the Franklin Railway Supply Company. He later became associated with the Bradford Corporation, specializing in locomotive throttles, and previous to his association with the Superheater Company was engaged by the American Throttle Company on special service work on the Bradford and Wagner locomotive throttles formerly manufactured by the Bradford Corp.

Obituary

John Obermier, vice-president of the Timken Roller Bearing Company, Canton, Ohio, died of pneumonia at Tucson, Ariz., on December 29.

MARINAC'S RAIL ODDITIES

Marinac has furnished us with the following explanation of the three cartoons which appear elsewhere in this issue:

Page 23. The small model locomotive which is complete in every detail was constructed by Eugene Stevens, of Norway, Maine. In working order it weighs only 150 lb. It is 5½ ft. long and can pull a load of a ton at high speed over its improvised track. The boiler holds two gallons of water and develops 120 lb. steam pressure, using coal as fuel. The tracks are laid trestle fashion on cedar posts. The midget steam gage, scarcely the size of a man's thumb, registers the pressure accurately. The cylinder bore is 1⅝ in. and the stroke 1¾ in. The tender carries six pounds of coal and 2½ gallons of water.

Page 42. Traffic blocks in the vicinity of fires in Amsterdam, Holland, are prevented by ingenious portable bridges that carry street cars and other vehicles over the hose lines. In a recent test these bridges enabled traffic to proceed at a normal pace along a street which was crossed by eight lines of hose. The bridges which are used to carry automobiles and horse-drawn vehicles consist of three low steel arches. The hose lines pass between the supports of these arches. For street cars, short sections of supplementary rail are used, with tooth-like lower edges and sloping ends. When these sections are laid upon the permanent rail the hose lines are passed through the sections, as shown.

Page 43. To solve the problem of handling expeditiously the vast quantities of mail that pour into the largest city in the world every day, London, England, postal authorities have constructed a network of underground tunnels for transferring the mail from the central postoffice to the branch stations in the outlying parts of the city. The sacks are conveyed from one point to another by means of small driverless trains, which travel at a speed of 25 miles per hour. When the train is loaded, an attendant pulls an overhead cord and the train starts off with its load, which is sometimes as much as 300 tons.

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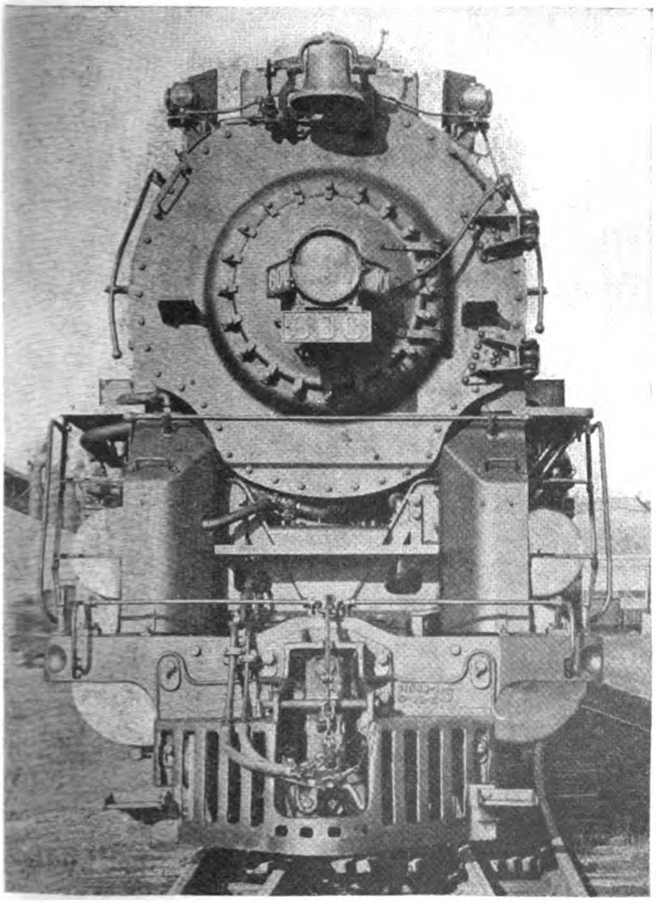
C. & O. 4-8-4 Type Locomotives For Heavy Passenger Service

Another road adopts 4-8-4 type —Lima delivers five high-capacity locomotives for mountain grade operation

OF the few steam locomotives built in 1935 the five of the 4-8-4 type from the Lima Locomotive Works, Inc., for the Chesapeake & Ohio represent the outstanding design. These locomotives, which are the first with this wheel arrangement to be used on the C. & O., are numbered from 600 to 604, inclusive, and are known as the "Greenbrier" type, or Class J-3. In addition to being numbered each locomotive has been given the name of a person who formerly lived in the territory served by the road and whose fame is nation wide. The names of those chosen were Th. Jefferson, Patrick Henry, Benj. Harrison, James Madison and Ed. Randolph.



Front view of C. & O. 4-8-4 type locomotive showing drop coupler

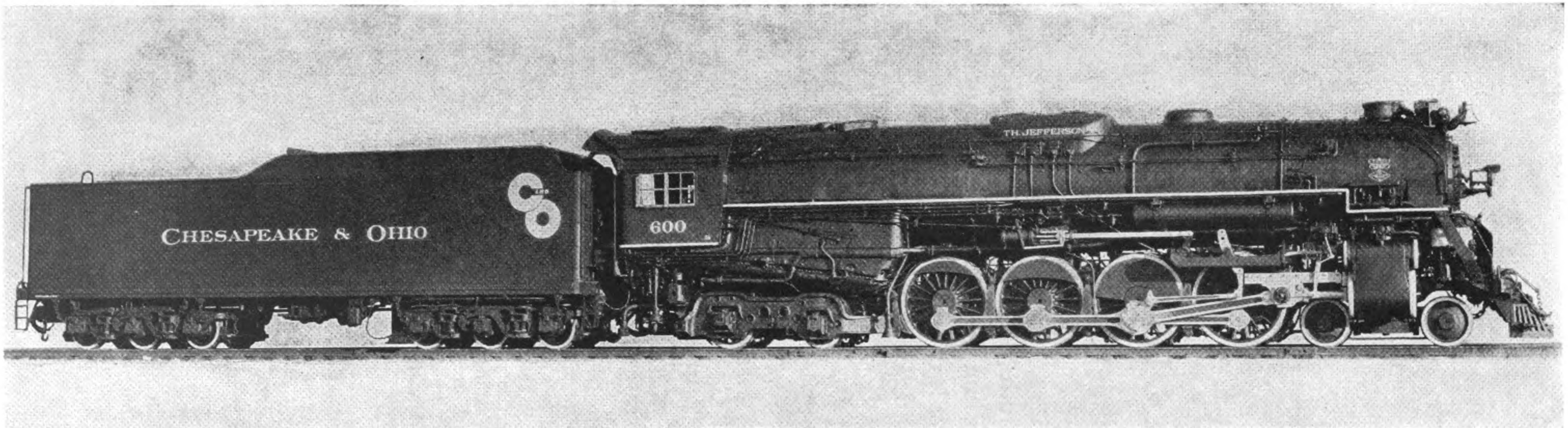
The service for which these locomotives were designed is the handling of heavy through passenger trains on the main line between Hinton, W. Va., and Charlottesville, Va., a distance of 175 miles. Between these points the C. & O. passes over two ranges of the Allegheny Mountains and one range of the Blue Ridge Mountains. The maximum ruling grades over these ranges vary from 1.33 to 1.52 per cent and are from three to eight miles in length. The new locomotives are being used to supplement those of the present Class J-2, U. S. R. A. heavy 4-8-2 type, now in passenger service in this territory. They will haul such trains as the George Washington, the Sportsman and the F. F. V., all of which are composed of modern, all steel, air-conditioned Pullmans, day coaches and tavern-type diners.

These locomotives have the largest combined heating surface of any locomotive of this type thus far built; namely, 7,880 sq. ft. The high total and the relatively high percentage of radiant heating surface is relied upon to produce a heat transfer which, combined with care throughout the design to effect high economy in the utilization of steam in the cylinders, is expected to provide a locomotive capable of developing not less than 5,000 cylinder horsepower.

The Boiler

The boiler, which carries a pressure of 250 lb. per sq. in., but is designed for a maximum of 260 lb., is of unusually generous capacity and, using the Cook formula, has an estimated evaporative capacity of 79,640 lb. per hour, including an eight per cent allowance for the feed-water heater. In addition, the design provides the largest steam space possible within the clearance limit.

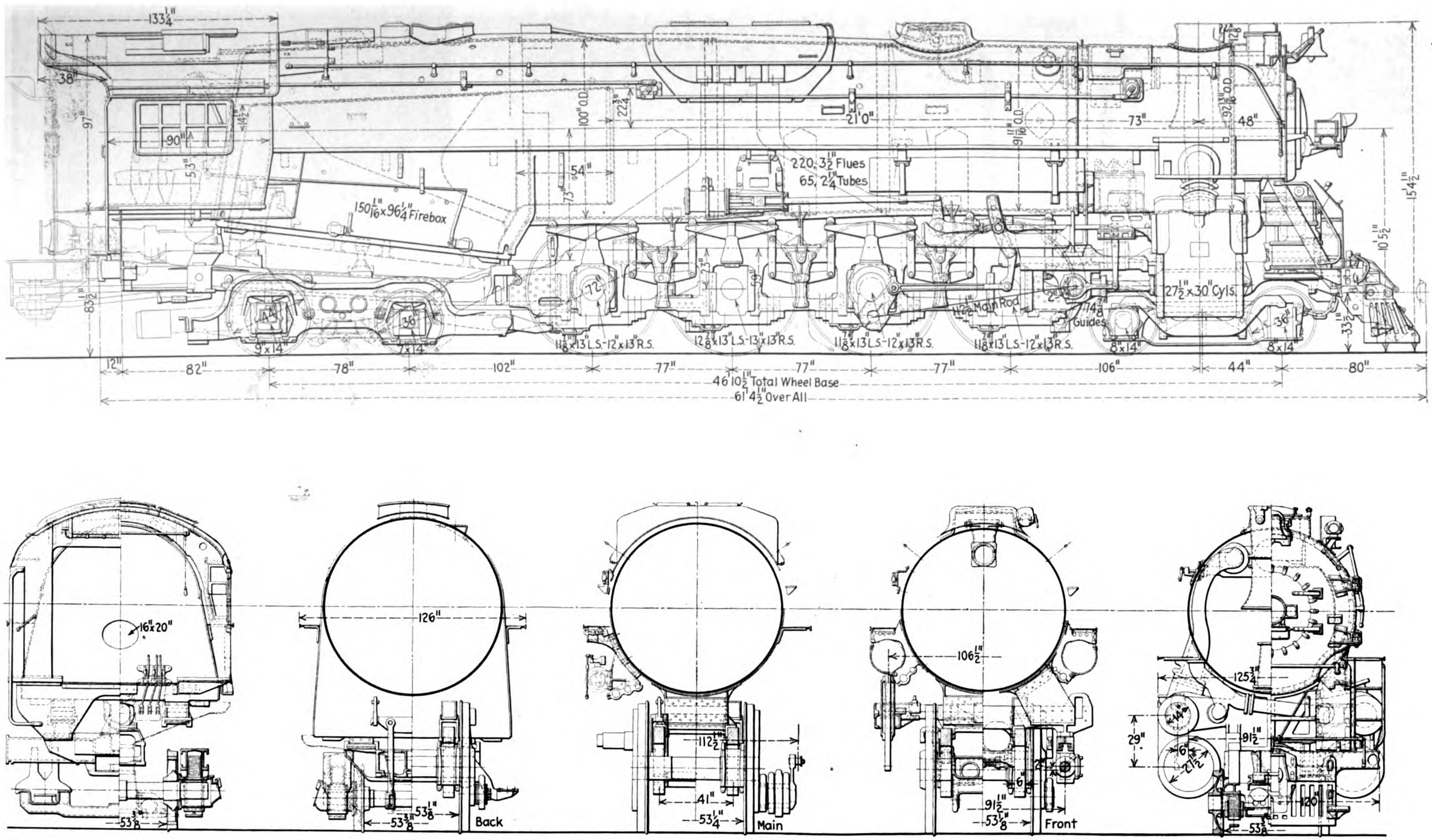
The shell, which is of the conical type, is made up of



Chesapeake & Ohio 4-8-4 type locomotive, Class J3, designed for heavy passenger traffic. Built by Lima Locomotive Works, Inc.

General dimensions, weights and proportions

Railroad	C. & O.
Builder	Lima Loco. Wks., Inc.
Type of locomotive	4-8-4
Number of locomotives	5
Road class	J-3
Road numbers	600-604
Date built	1935
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	15-4½
Height to center of boiler, ft. and in.	10-5½
Width overall, in.	126
Cylinder centers, in.	91½
Weights in working order, lb.:	
On drivers	273,000
On front truck	89,500
On trailing truck	53,000 Front 61,000 Back
Total engine	477,000
Tender, loaded	381,700
Wheel bases, ft. and in.:	
Driving	19- 3
Rigid	12-10
Front truck, in.	88
Trailing truck, in.	78
Engine, total	46-10½
Engine and tender, total	98- 5¼
Wheels, diameter outside tires, in.:	
Driving	72
Front truck	36
Trailing truck	36 and 44
Engine:	
Cylinders, number, diameter and stroke, in.	2-27½ × 30
Valve gear, type	Walschaert
Valves, piston type, size, in.	14
Maximum travel, in.	7½
Steam lap, in.	1⁹⁄₁₆
Exhaust clearance, in.	³⁄₁₆
Lead, in.	¼
Cutoff in full gear, per cent	79.7
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	250
Diameter, first ring, outside in.	91¹¹⁄₁₆
Diameter, largest outside in.	100
Firebox, length, in.	150¹⁄₁₆
Firebox, width, in.	96¼
Height mud ring to crown sheet, back, in.	67½
Height mud ring to crown sheet, front, in.	95¾
Combustion chamber length, in.	54
Arch tubes, number and diameter, in.	2-3½
Thermic Syphons, number	2
Tubes, number and diameter, in.	65-2¼
Flues, number and diameter, in.	220-3½
Length over tube sheets, ft. and in.	21-0
Net gas area through tubes and flues, sq. ft.	10.6
Fuel	Soft-coal
Grate area, sq. ft.	100
Heating surfaces, sq. ft.:	
Firebox and combustion chamber	396
Arch tubes and Thermic Syphons	129
Firebox, total	525
Tubes and flues	5,013
Evaporative, total	5,538
Superheating (Type E)	2,342
Combined evap. and superheat	7,880
Tender:	
Style or type	Rectangular
Water capacity, U. S. gal.	22,000
Fuel capacity, tons	25
Trucks	6-wheel
Journals, diameter and length, in.	7 × 14
General Data, estimated:	
Rated tractive force, main engine, lb.	66,960
Rated tractive force, booster	14,075
Total rated tractive force, lb.	81,035
Speed at 1,000 ft. per min. piston speed, m.p.h.	42.85
Piston speed at 10 m.p.h. ft. per min.	235
R.p.m. at 10 m.p.h.	46.7
Boiler evap. (with heater) (Cook) lb. per hr.	79,640
Equiv. evap. per sq. ft. evap. h.s. per hr.	14.38
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	57.2
Weight on drivers ÷ tractive force	4.08
Weight of engine ÷ evaporation	5.99
Weight of engine ÷ comb. heat. surface	60.53
Boiler proportions:	
Firebox h.s. per cent comb. h.s.	6.7
Tube-flue h.s. per cent comb. h.s.	63.6
Superheat. surface per cent comb. h.s.	29.7
Firebox h.s. ÷ grate area	5.25
Tube-flue h.s. ÷ grate area	50.13
Superheat. surface ÷ grate area	23.42
Comb. h.s. ÷ grate area	78.80
Gas area, tubes and flues ÷ grate area	0.11
Evaporation ÷ grate area	796.4
Tractive force ÷ grate area	669.6
Tractive force ÷ evaporation	0.84
Tractive force ÷ comb. h.s.	8.50
Tractive force × dia. drivers ÷ comb. h.s.	6.12



Elevation and cross-sections of the Chesapeake & Ohio 4-8-4 type passenger locomotives

three courses of nickel steel. The first is $91\frac{11}{16}$ in. in outside diameter and $\frac{27}{32}$ in. thick; the second, which is tapered, is $\frac{29}{32}$ in. thick, and the third, which extends to the throat, is 100 in. in outside diameter and $\frac{15}{16}$ in. thick. The firebox, which has a combustion chamber 54 in. long, contains two Thermic Syphons which are supplemented by two arch tubes for the support of the Security brick arch. The crown sheet has a slope of $8\frac{1}{4}$ in. and a space of $29\frac{1}{2}$ in. is provided between the crown sheet and the roof sheet. There are 65 $2\frac{1}{4}$-in. tubes and 220 $3\frac{1}{2}$-in. flues, the length over tube sheets being 21 ft. The dome, with an opening 32 in. in diameter and a height of only 9 in., is located on the first shell course, 6 ft. $\frac{7}{8}$ in. back of the tube sheet. The total length of the boiler, including the smokebox which is 121 in. long, is 49 ft. $5\frac{1}{4}$ in.

The grate has an area of 100 sq. ft. and a slope from back to front of 20 in. The grates are of the Firebar type and the coal is fed by a Standard Type MB stoker.

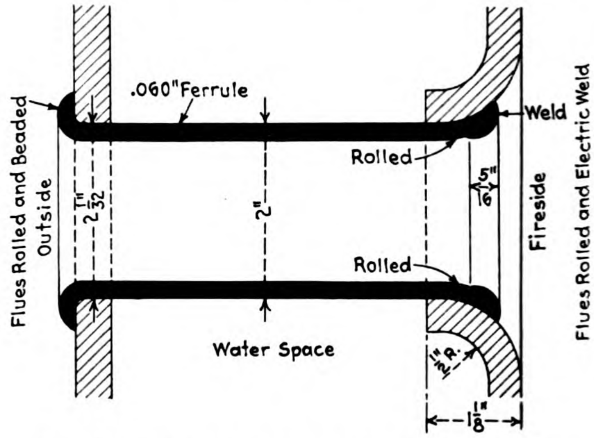
Special Equipment Applied on C. & O. 4-8-4 Type Locomotives

Builder	Lima Locomotive Works, Inc.
Road Numbers	600-604
Boiler:	
Boiler, steel, nickel	Lukens Steel Co.
Firebox steel, firebox, crown and side	Otis Steel Co.
Staybolts, flexible (Welded)	Flannery Bolt Co.
Thermic Syphons	Locomotive Firebox Co.
Brick arch (Security)	American Arch Co.
Superheater (type E)	Superheater Co.
Throttle valve, multiple	American Throttle Co.
Feedwater heater (type 5S)	Worthington Pump & Machy. Corp.
Injector, live steam	Nathan Mfg. Co.
Grates (Firebar)	Waugh Equipment Co.
Stoker (type MB)	Standard Stoker Co.
Firedoor (Butterfly 8A)	Franklin Ry. Supply Co.
Blowoff cocks, 2 in.	Wilson Engineering Corp.
Plugs, arch tube	Huron Manufacturing Co.
Plugs, throat sheet, syphon	Housley Flue Connection Corp.
Plugs, washout	Huron Manufacturing Co.
Steampipe casing (Flextite)	American Locomotive Co.
Hinges, smokebox	Okadee Co.
Lagging (85 per cent magnesia)	Johns-Manville Sales Corp.
Cab Fittings and Boiler Mountings:	
Safety valves	Consolidated Ashcroft Hancock Co.
Water column	Nathan Mfg. Co.
Whistle	Nathan Mfg. Co.
Bell ringer (improved Golmar)	Viloco Ry. Equipment Co.
Sanders	Viloco Ry. Equipment Co.
Reducing valve, steam heat	Gold Car Heating Co.
Headlight generator	Pyle National Co.
Headlight case	Pyle National Co.
Windows, storm	Prime Mfg. Co.
Cylinders and Driving Gear:	
Cylinders, steel	Ohio Steel Foundry Co.
Packing, piston rod and valve stem	Garlock Packing Co.
Cylinder cocks	Okadee Co.
Reverse gear (type E)	American Locomotive Co.
Tandem main rods	Lima Locomotive Works
Booster, trailing truck (type C2)	Franklin Ry. Supply Co.
Frames and Running Gear:	
Frames, cast steel	Ohio Steel Foundry Co.
Pilot, cast steel, drop coupler	General Steel Castings Co.
Lateral cushioning device, front wheels	American Locomotive Co.
Driving wheel centers, cast steel	Ohio Steel Foundry Co.
Truck, engine	General Steel Castings Co.
Truck, trailing (Delta 4-wheel)	General Steel Castings Co.
Wheels, engine truck, rolled steel	Carnegie-Illinois Steel Corp.
Wheels, trailer, front, rolled steel	Carnegie-Illinois Steel Corp.
Wheels, trailer, rear, centers	Ohio Steel Foundry Co.
Springs	Pittsburgh Spring & Steel Co.
Lubrication:	
Lubricators, mechanical (32B) (3)	Detroit Lubricator Co.
Lubricators, mechanical (24 pint, 16 feed) (2)	Nathan Mfg. Co.
Lubricators, hydrostatic, (3 pint, 3 feed)	Nathan Mfg. Co.
Brakes:	
Air brake (6ET)	New York Air Brake Co.
Air compressors (2-8½ in. C.C.)	New York Air Brake Co.
Driver brakes (WN 4)	American Brake Co.
Tender truck (Simplex)	American Steel Foundries
Brake shoes	American Brake Shoe & Fdry. Co.
Train control	Union Switch & Signal Co.
Couplers and Draft Gear:	
Coupler, engine (drop type)	National Malleable & Steel Cast. Co.
Coupler, tender (type E)	Buckeye Steel Castings Co.
Coupler yoke, tender	Buckeye Steel Castings Co.
Draft gear, tender	Cardwell Westinghouse Co.
Tender:	
Frame, water bottom	General Steel Castings Co.
Drawbar (Unit Safety)	Franklin Ry. Supply Co.
Buffer, radial (A1)	Franklin Ry. Supply Co.
Flexible connections	Barco Mfg. Co.
Tank valves	William Powell Co.
Trucks, six-wheel	Buckeye Steel Castings Co.
Wheels (Davis multiple-wear)	American Steel Foundries
Journal boxes	Buckeye Steel Castings Co.
Journal box lids	Buckeye Steel Castings Co.

Six combustion tubes are provided, three on each side.

The boiler is fitted with the Elesco Type E superheater, with the American multiple throttle and a Worthington type 5-S feedwater heater of 9,000 gal. capacity. The drypipe is of $10\frac{1}{2}$ in. inside diameter. Superheated steam is used for the blower. All other auxiliaries are operated by saturated steam taken from a cast steel cab turret. The safety valves are mounted on a cast-steel turret attached to the roof sheet.

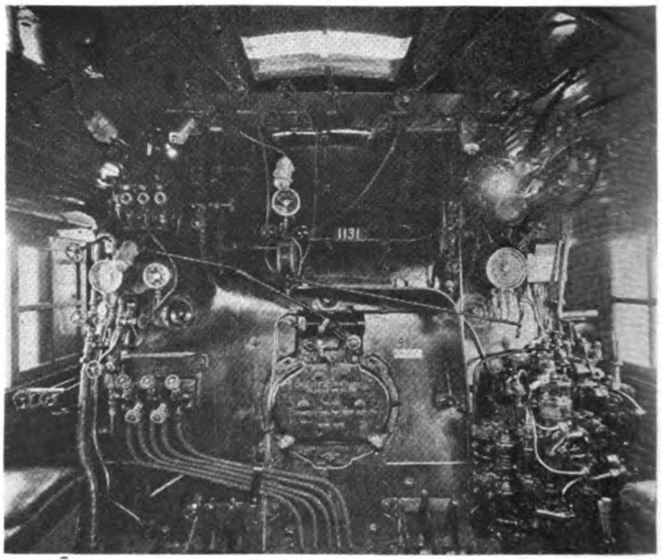
Welding has been employed at many points in the construction of the boiler. In the firebox the crown



Detail construction of the combustion tubes

sheet is butt-welded to the side sheets, the bottom sheet of the combustion chamber is butt-welded to the crown sheet, the Thermic Syphons are welded to the crown and throat sheets, the inside throat sheet is butt-welded all around, the firedoor sheet seams are butt-welded from the bottom of the mud ring up to the center line of the boiler and the firedoor hole seam is butt-welded. The mud ring calking edges are seal welded to both inside and outside sheets for a distance of 24 in. from each side of the center line of the corner, except at the front where the outside sheet is seal welded longitudinally for 40 in. back from the corner. The back head seams are sealed by welding from the bottom of the mud ring to the top of the seam between the outside wrapper and the side sheets, the outside wrapper and side-sheet seams are seal welded at the throat connection from the bottom of the mud ring on one side over the top of the boiler

(Continued on page 59)



View in cab of back boiler head and fittings

Equipment Orders in 1935 Fewer than in 1934

Domestic orders totaled 28 steam, 7 electric and 48 internal-combustion locomotives; 18,689 freight and 63 passenger train cars; 3 motor trains and 15 motor cars or body units. Canadian orders included 27 locomotives and 2,421 freight cars

PURCHASES of motive power and rolling stock in 1935 were unusually light, in fact, in only two or three years since 1901 has the volume of business been smaller. This was true of all kinds of equipment.

Locomotive Orders

In 1935 the railroads in the United States ordered 24 steam locomotives and those in Canada 22 steam locomotives. An additional eight locomotives for industrial service and 13 for export brought the total orders for steam locomotives up to 67. All the export orders were for South America with the exception of a single locomotive for Cuba. Of the locomotives for domestic or Canadian service 17, or 37 per cent, of the total were of the 4-8-4 type. These included five for the C. & O., 10 for the Canadian National (five each for freight and passenger service) and two for the Temiskaming & Northern Ontario. The Canadian Pacific ordered five of the 4-4-4 type for high-speed passenger service with light-weight cars. Other orders included four of the 2-8-4 type by the D. T. & I., two of the 4-8-2 type by the B. & M., eight of the 0-6-0 type by the W. & L. E. and two of the 2-6-6-4 type by the N. & W., the latter two orders being for construction at company shops. The B. & O. and the C. B. & Q. are each building one locomotive of the 4-6-4 type.

Table I—Orders for Locomotives of All Types Since 1918

Year	Domestic	Canadian	U. S. Export	Total
1918	2,593	209	2,086	4,888
1919	214	58	898	1,170
1920	1,998	189	718	2,905
1921	239	35	546	820
1922	2,600	68	131	2,799
1923	1,944	82	116	2,142
1924	1,413	71	142	1,626
1925	1,055	10	209	1,274
1926	1,301	61	180	1,542
1927	734	58	54	846
1928	603	98	27	728
1929	1,212	77	106	1,395
1930	440	95	20	555
1931	176	2	28	206
1932	12	1 (Export)	1	14
1933	42	...	7	49
1934	182	...	17	199
1935	83	27	15	125

The 4-8-4 type again leads the steam-locomotive field. This type has fully demonstrated its ability to meet the exacting requirements for handling either heavy and fast passenger trains or heavy freight trains at the high speeds now found advisable. Probably the most notable design of the year was that of the C. & O. 4-8-4 type locomotives built for heavy passenger service on grades up to 1.5 per cent. These locomotives have unusually ample boilers and are expected to develop over 5,000 cylinder horsepower. For heavy power the N. & W. articulated locomotives are of interest. Their rated tractive force will be 104,500 lb. The tendency toward increased running speeds during 1934 has been still more noticeable in 1935. The success of the Hiawatha locomotives on the C. M. St. P. & P. has helped to focus attention on streamlining which is being experimented with in all parts of the world. Furthermore, recent steam locomotive performance has demonstrated the ability of this type of motive power to meet all service demands now visualized.

Only seven electric locomotives were ordered. Of these, only one was for railroad service—the Norfolk & Western. Since the developments on the Pennsylvania in 1934 new activity in this field has been dormant.

Orders for internal combustion locomotives in 1935 totaled 48 for service in the United States. Of these, nine were for railroad service and 39 for industrial service. With the exception of the Belt Ry. of Chicago no railroad ordered more than one locomotive. There was one 1,000-hp. Diesel-electric locomotive for the F. W. & D. C., one of 900 hp. for the P. B. & N. E., two of 600 hp. for the Belt Ry. of Chicago, and one each of 600 hp. for the A. T. & S. F., C. & I. W., and P. & P. U. Most of the locomotives ordered for industrial service were of relatively small size, only one was of 600 hp. capacity. In addition to those for domestic service, two small locomotives were ordered for export and one locomotive of 600 hp. was ordered by the Canadian Pacific.

Table II—Types and Number of Steam Locomotives Ordered in 1935

Type	Railroad U. S. and Canada	Industrial service	Export	Total
0-4-0	..	1	..	1
0-6-0	8	3	..	11
0-8-0	1	..	..	1
2-8-0	..	1	2	3
2-8-2	5	1	1	7
2-8-4	4	..	..	4
2-6-6-2	..	..	1	1
2-6-6-4	2	..	..	2
4-4-4	5	..	..	5
4-6-4	2	..	..	2
4-8-0	..	..	5	5
4-8-2	2	..	..	2
4-8-4	17	..	..	17
4-10-2	..	..	4	4
Geared	..	2	..	2
Total	46	8	13	67

The year 1935 marked the entrance of the Diesel-electric locomotive into main line passenger service. The A. T. & S. F. 3,600-hp., double-unit and the B. & O. 1,800-hp. single-unit Diesel-electric locomotives were placed in service. Another 3,600-hp. double-unit, owned by the builder, has been on trial service on several railroads. A description of the Santa Fe loco-

motive was given in the December, 1935, issue of the *Railway Mechanical Engineer.*

Freight Car Orders

Referring to Table III it will be noted that the orders for freight cars in 1935 included 18,699 for the United States, 2,421 for Canada and 110 for export. In only three years since 1901—1931, 1932 and 1933—has the total been so small. Information as to the types of cars ordered will be found in Table IV. This table shows also the distribution as between railroads and private car lines. Excluding export orders, 10,020 or 47 per cent were of the box or automobile type; 6,144 or 29 per cent of the hopper type; 3,175 or 15 per cent of the gondola type and 1,205 or 5.7 per cent of the refrigerator type. Of the refrigerator cars credited to railroads all were for Canadian roads. Of the cars ordered in the United States 11,138 were placed with outside builders and 7,561 with railroad shops.

Table III—Orders for Freight Cars Since 1918

Year	Domestic	Canadian	Export	Total
1918	114,113	9,657	53,547	177,317
1919	22,062	3,837	3,994	29,893
1920	84,207	12,406	9,056	105,669
1921	23,346	30	4,982	28,358
1922	180,154	746	1,072	181,972
1923	94,471	8,685	396	103,552
1924	143,728	1,867	4,017	149,612
1925	92,816	642	2,138	95,596
1926	67,029	1,495	1,971	70,495
1927	72,006	2,133	646	74,785
1928	51,200	8,901	2,530	62,631
1929	111,218	9,899	3,023	124,140
1930	46,360	1,936	1,200	49,496
1931	10,880	3,807	151	14,838
1932	1,968	501	77	2,546
1933	1,685	75	132	1,892
1934	24,611	12	1,323	25,946
1935	18,699	2,421	110	21,230

The largest number of freight cars ordered by any railroad in 1935 was 10,100 for the Pennsylvania. Other orders included 5,230 for the C. & O., 505 for the C. B. & Q., 500 for the C. N. O. & T. P., 500 for the Norfolk Southern, 500 for the Northern Refrigerator Line, Inc., and 485 for the N. & W. The Canadian National ordered 1,180 cars and the Canadian Pacific 1,120 cars. These Canadian orders were made possible by government loans, for which reason the Canadian orders were much larger than for several years. In placing orders for box cars there appears to be a marked tendency to follow the A. A. R. standard design. As regards the design of refrigerator cars it may not be out of place to call attention to the fact that the A. A. R. Committee on Car Design are working on a standard design and have reported progress. In methods of construction there appears to be an increased use of the welding process.

Table IV—Class and Number of Freight Cars Ordered in 1935

Class	United States and Canada Railroads	Private	Total	Export
F—Flat	75	..	75	..
G—Gondola	3,170	5	3,175	..
H—Hopper	6,140	4	6,144	30
HR—Covered Hopper	30	12	42	..
R—Refrigerator	600	605	1,205	..
T—Tank	..	269	269	2
X—Box	8,920	..	8,920	75
XA—Auto. Box	1,100	..	1,100	..
S—Stock	50	..	50	..
N—Caboose	27	..	27	..
Not classified	83	30	113	..
Total	20,195	925	21,120	110

An indication of the trend of current thought is shown in the construction of a few box and hopper cars in which special steels were employed in order to reduce the tare weight and thereby increase the ratio of revenue load to total gross weight. At the same time an increased life due to decreased corrosion is anticipated. The exact economic evaluation of the reduction in weight and the decrease in corrosion can, of course, be determined accurately only by extended service. The actual construction of such cars is, however, significant.

Passenger Equipment Orders

Orders for passenger train cars in 1935 amounted to the insignificant total of 79. The largest order was one for 55 milk cars placed by the Erie. Other orders included eight coaches, four baggage and buffet, and four mail and express cars for the Canadian Pacific, two D. & R. G. W. air-conditioned diner-observation cars to be built at the railroad's shops and two light-weight coaches for the A. T. & S. F.—one of stainless steel and one of Cor-Ten steel. These light-weight cars are to be used interchangeably with regular passenger-train equipment and are significant in indicating what the trend of future designs may be.

Table V—Orders for Passenger Train Cars Since 1918

Year	Domestic	Canadian	Export	Total
1918	9	22	26	57
1919	292	347	143	782
1920	1,781	275	38	2,094
1921	246	91	155	492
1922	2,382	87	19	2,488
1923	2,214	263	6	2,483
1924	2,554	100	25	2,679
1925	2,191	50	76	2,317
1926	1,868	236	58	2,162
1927	1,612	143	48	1,803
1928	1,930	334	29	2,293
1929	2,303	122	33	2,458
1930	667	203	15	885
1931	11	11	21	43
1932	39	..	..	39
1933	6	..	..	6
1934	388	..	15	403
1935	63	16	..	79

In the field of motor-driven equipment the C. B. & Q. ordered one completely articulated train of four body units, driven by a 660-hp. Diesel-electric power plant, while the Union Pacific ordered two complete trains. The first units in these two trains will be two power cars with a total of 2,400 hp. in Diesel-electric plants, while the train proper will consist of 10 cars, partially articulated. A brief description of these trains, which will be operated between Chicago and Denver, was given in the January issue of the *Railway Mechanical Engineer.* In addition, orders were given for six additional cars for existing motor trains—one of two articulated body units and the others single units. Nine single-unit rail motor cars were also ordered. Two of these—Seaboard Air Line—had 600-hp. Diesel-electric power plants while gasoline engines were specified for the others. Included among the single-unit cars were three light rail-buses for the Seaboard Air Line and two for the Norfolk Southern. The only export order was one for four small gasoline rail-motor cars to be shipped to Colombia.

As will be noted from the list given, the rail-motor equipment ordered in 1935 covered a wide range—all the way from the single-unit rail-buses weighing 42,000 lb. and having a 180-hp. engine with no provision for hauling a trailer which were ordered by the Norfolk Southern to the 11-car trains with 2,400-hp. locomotives ordered by the Union Pacific.

Equipment Condition

The lessened demands for motive power and rolling stock during the past few years due to a greatly reduced

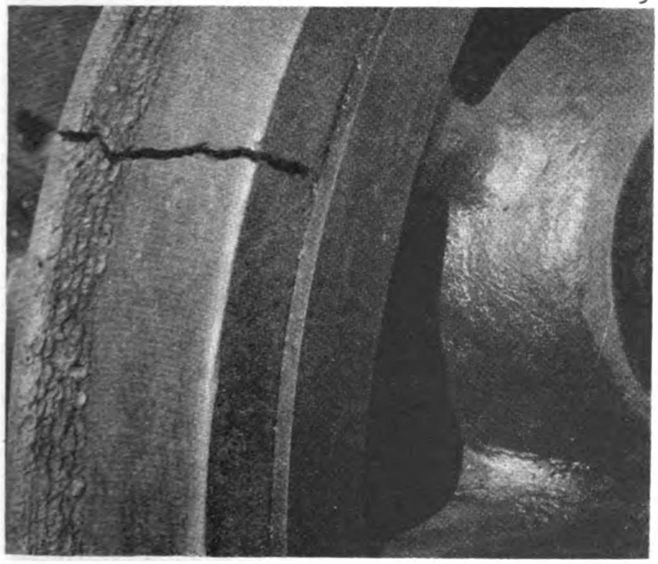
volume of traffic have permitted the railroads to withdraw much of their older, lighter or poorer equipment from service and to handle such traffic as was available with their newer and better equipment. As a consequence operating results both as to speeds and fuel consumption have been highly creditable. However, the best of the equipment which was purchased less than 10 years ago is now in a condition where heavy expenditures for its maintenance must soon be made. Furthermore, it is quite generally recognized that a considerable portion of the locomotive and car inventories that have been withdrawn from active service can never again be reconditioned to be operated economically. Realizing this, a number of roads have set up definite retirement programs. The number of units of all types of locomotives and cars is steadily declining. During the past six years the decline has averaged annually 1,877 locomotives, 1,749 passenger train cars and 83,310 railroad-owned freight cars. On Class I railroads since 1929 the total number of locomotives has shown a decline of 19.4 per cent and the aggregate tractive capacity 13 per cent. While the number of unserviceable locomotives has been increasing it is feared that many of the locomotives reported as "stored serviceable" will, on account of type, size or design, be of but little practical value when a real demand for power arises. These is no disguising the fact that railroad motive power and rolling stock is getting to be not only old but some of it also too antiquated ever again to render satisfactory service. Heavy expenditures will have to be made not only for rehabilitation of such present equipment as can be economically repaired and returned to service but also for the purchase of new and modern equipment to meet the demands for higher speeds and better service which are now expected by the general public.

Annual Report of the Bureau of Locomotive Inspection

Twenty-fourth annual report again shows an increase in accidents and number of locomotives found defective

THE twenty-fourth annual report of A. G. Pack, chief inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission shows that the record of improvement in the condition of steam locomotives and the death and accidents resulting therefrom which began in 1923 was continued steadily until 1932. Since that time there has been a steadily increasing number of accidents and each year more locomotives have been found to be defective.

The total number of steam locomotives inspected by the Bureau during the past fiscal year was 94,151, of which 11,071 or 12 per cent, were defective. This compared with 10,713 defective locomotives in the year ended June 30, 1934, 8,338 in 1933, and 7,724 in 1932. The number of locomotives ordered out of service increased to 921 against a low of 527 in 1932, while the total number of defects found was 44,491 against 27,832 in 1932, 32,733 in 1933, and 43,271 in 1934. The number of accidents due to defective locomotives showed an increase, while the number of persons killed rose to 29 against only 7 the year before.



Driving-wheel tire broken as a result of building up the flange by fusion welding

During the year 12 per cent of the steam locomotives inspected were found with defects or errors in inspection that should have been corrected before the locomotives were put into use as compared with only 8 per cent in the year ended June 30, 1932. There was an increase of 22 per cent in the number of locomotives ordered withheld from service because of defects that rendered them immediately unsafe as compared with the previous year, and an increase of 2.8 per cent in the total number of defects found. A comparison of the number of defects found over a six-year period is shown in one of the tables, from which it will be noted that the increase in

Condition of Locomotives, Found by Inspection, in Relation to Accidents and Casualties

Fiscal year ended June 30	Per cent of locomotives inspected found defective	Number of locomotives ordered out of service	Number of accidents	Number of persons killed	Number of persons injured
1925	46	3,637	690	20	764
1926	40	3,281	574	22	660
1927	31	2,539	488	28	517
1928	24	1,725	419	30	463
1929	21	1,490	356	19	390
1930	16	1,200	295	13	320
1931	10	688	230	16	269
1932	8	527	145	9	156
1933	10	544	157	8	256
1934	12	754	192	7	223
1935	12	921	201	29	267

the number of defects is represented largely by items that require heavy repairs to restore the deferred maintenance.

Boiler Explosions or Crown-Sheet Failures

Boiler explosions or crown-sheet failures continue to be the most prolific source of fatal accidents. There was an increase of four accidents, an increase of 17 in the number of persons killed, and of 39 in the number injured from this cause, as compared with the previous year. Compared with the fiscal year ended June 30, 1912—the first year the Boiler Inspection Act was operative—there has been, however, a marked improvement in conditions.

Extension of Time for Removal of Flues

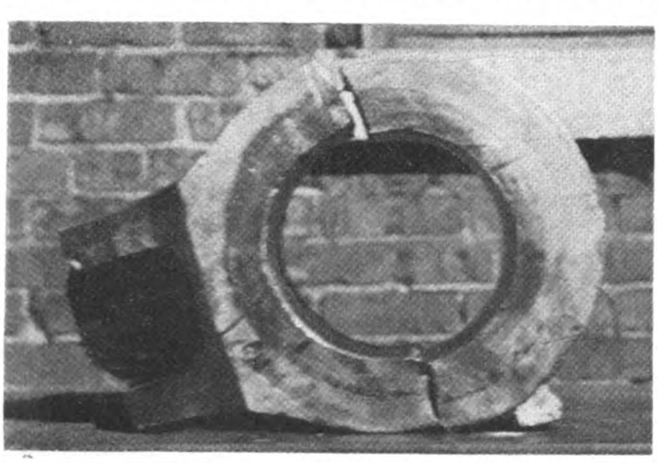
A total of 1,401 applications were filed for extensions of time for removal of flues, as provided in Rule 10. Investigations disclosed that in 84 of these cases the condition of the locomotive was such that an extension could not be granted. One hundred twenty-nine were in such condition that full extensions requested could not be authorized, but extensions for shorter periods were allowed. Extensions were granted in 141 cases after defects disclosed by investigations were repaired. Twenty applications were canceled for various reasons. Applications totaling 1,027 were granted for the full period requested.

Other Types of Locomotives

Inspection made of locomotives other than steam showed the same trend of increasing defects and a greater number of accidents. Compared with the previous year the number of locomotives found defective increased from 69 to 146, and the number of defects from 158 to 447. There were eight persons injured due to defects against only one in 1934. No deaths due to defective equipment have occurred in the past four years.

Specification Cards and Reports

Under Rule 54 for Inspection and Testing of Steam Locomotives 209 specification cards and 3,185 alteration reports were filed, checked and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constructed or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found. Under Rules 328 and 329 for Inspection and Testing of Locomotives Other than Steam 308 specifications and 29 alteration reports were filed for locomotive units and 92 specifications and 62 alteration reports for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found. No formal appeal by any carrier was taken from the decisions of any inspector during the year.



Front end of main rod that failed due to application of bronze by fusion welding to take up lateral wear

Number of Steam Locomotives Reported, Inspected, Found Defective, and Ordered from Service

Parts defective, inoperative or missing or in violation of rules	Year ended June 30— 1935	1934	1933	1932	1931	1930
1. Air compressors	733	660	474	417	481	873
2. Arch tubes	74	127	51	54	60	87
3. Ash pans & mechanism	94	87	40	69	81	76
4. Axles	10	6	21	13	10	12
5. Blow-off cocks	283	289	210	144	191	325
6. Boiler checks	413	407	293	214	263	521
7. Boiler shell	395	372	296	220	430	579
8. Brake equipment	2,449	2,326	1,696	1,645	1,923	2,706
9. Cabs, cab windows and curtains	1,273	1,342	1,183	851	1,484	3,066
10. Cab aprons and decks	368	343	309	262	415	710
11. Cab cards	142	129	121	162	211	226
12. Coupling and uncoupling devices	73	54	67	85	98	122
13. Crossheads, guides, pistons, and piston rods	1,086	1,100	773	763	856	1,421
14. Crown bolts	75	77	67	50	96	95
15. Cylinders, saddles, and steam chests	1,547	1,491	1,084	841	1,265	2,311
16. Cylinder cocks and rigging	627	654	374	376	411	848
17. Domes and dome caps	94	105	76	45	83	154
18. Draft gear	423	401	318	325	568	950
19. Draw gear	414	480	357	371	640	1,003
20. Driving boxes, shoes, wedges, pedestals, and braces	1,573	1,472	1,080	821	925	1,359
21. Firebox sheets	343	356	246	235	341	471
22. Flues	173	203	150	120	187	254
23. Frames, tailpieces, and braces, locomotive	1,006	951	669	611	740	1,271
24. Frames, tender	124	128	80	86	105	177
25. Gages and gage fittings, air	275	212	145	156	192	290
26. Gages and gage fittings, steam	320	289	258	214	324	553
27. Gage cocks	480	384	388	330	415	783
28. Grate shakers and fire doors	394	404	245	288	410	767
29. Handholds	464	377	363	382	562	865
30. Injectors, inoperative	39	33	20	31	55	103
31. Injectors and connections	2,035	1,909	1,357	1,168	1,815	3,275
32. Inspections and tests not made as required	8,344	8,173	6,358	3,801	4,862	7,456
33. Lateral motion	389	351	269	237	289	372
34. Lights, cab and classification	81	79	76	55	77	119
35. Lights, headlights	257	218	169	119	180	373
36. Lubricators and shields	191	215	157	119	176	312
37. Mud rings	241	247	232	166	318	445
38. Packing nuts	527	491	419	402	523	828
39. Packing, piston rod and valve stem	906	833	592	444	706	1,429
40. Pilot and pilot beams	152	174	123	145	160	272
41. Plugs and studs	167	242	151	176	182	348
42. Reversing gear	414	390	254	202	299	579
43. Rods, main and side, crank pins, and collars	1,826	1,670	1,327	1,256	1,520	2,488
44. Safety valves	100	103	53	63	61	116
45. Sanders	779	697	376	289	314	804
46. Springs and spring rigging	2,765	2,854	2,122	1,851	2,161	3,311
47. Squirt hose	113	107	93	96	184	313
48. Stay bolts	140	285	219	181	293	395
49. Stay bolts, broken	512	455	368	552	938	1,098
50. Steam pipes	463	489	338	285	512	730
51. Steam valves	212	267	193	143	226	399
52. Steps	640	567	498	622	676	1,021
53. Tanks and tank valves	913	862	600	587	732	1,426
54. Telltale holes	102	93	90	108	151	183
55. Throttles and throttle rigging	733	639	448	434	574	1,175
56. Trucks, engine and trailing	811	898	664	648	714	1,141
57. Trucks, tender	1,120	918	747	766	1,059	1,531
58. Valve motion	799	784	640	520	497	827
59. Washout plugs	679	776	623	599	815	1,283
60. Train-control equipment	4	8	4	13	9	48
61. Water glasses, fittings and shields	951	907	716	676	955	1,501
62. Wheels	697	734	580	603	750	1,025
63. Miscellaneous — signal appliances, badge plates, brakes (hand)	563	572	423	325	418	691
Total number of defects	44,491	43,271	32,733	27,832	36,968	60,292
Locomotives reported	51,283	54,283	56,971	59,110	60,841	61,947
Locomotives inspected	94,151	89,716	87,658	96,924	101,224	100,794
Locomotives defective	11,071	10,713	8,388	7,724	10,277	16,300
Percentage of inspected found defective	12	12	10	8	10	16
Locomotives ordered out of service	921	754	544	527	688	1,200

Turbine Locomotive Built by London, Midland & Scottish

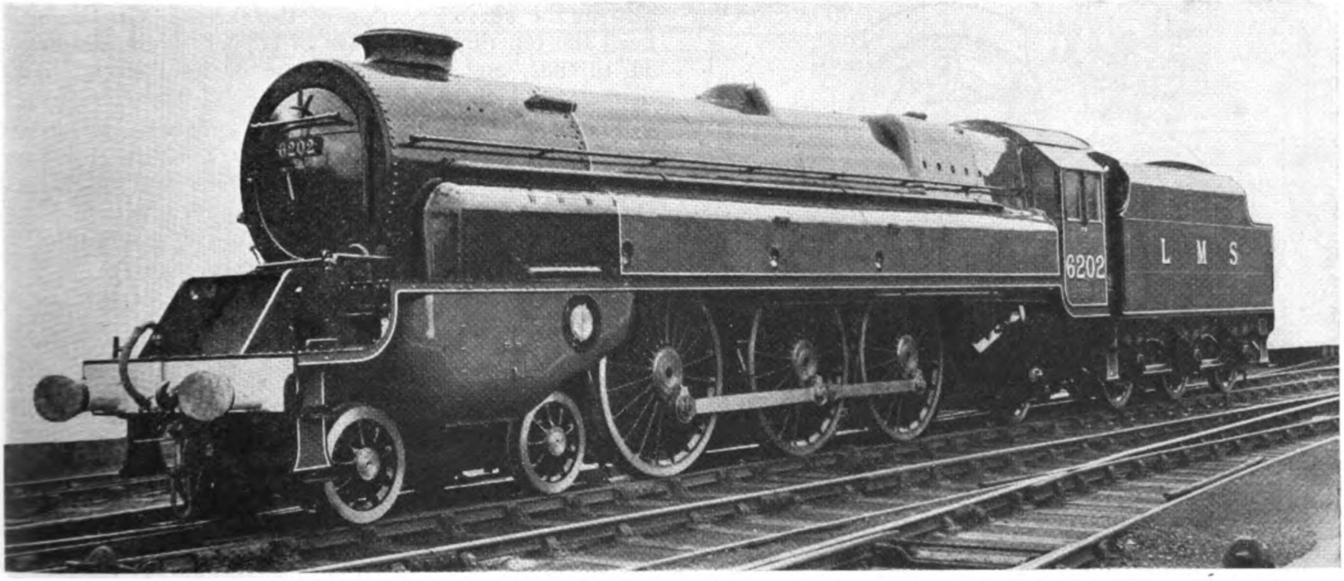
Non-condensing turbine locomotive differs in the fewest particulars from other 4-6-2 standard type locomotives

THE London, Midland & Scottish Railway has recently completed at its Crewe Works a turbine locomotive, No. 6202, built for test purposes. This locomotive, which is of the Pacific type, is fitted with a non-condensing turbine of the Ljungstrom-Lysholm type, the turbine and the reduction gearing being designed and supplied by the Metropolitan Vickers Electrical Company, Ltd. In reality two turbines are employed, an ahead turbine located on the left-hand side in the place usually occupied by the reciprocating-engine cylinder and steam chest and a reverse turbine located on the right-hand side. The ahead turbine has six nozzles, two Curtis stages and several expansion stages. It is permanently connected to the triple-reduction gear located between the frames underneath the smokebox. The reduction gear is coupled to the leading pair of driving wheels by means of a quill drive of a general design similar to that used on some electric locomotives. This turbine develops over 2,000 hp. at full admission. The reverse turbine, which is smaller, has three nozzles and two Curtis stages. When the locomotive is running ahead the reverse turbine is disconnected.

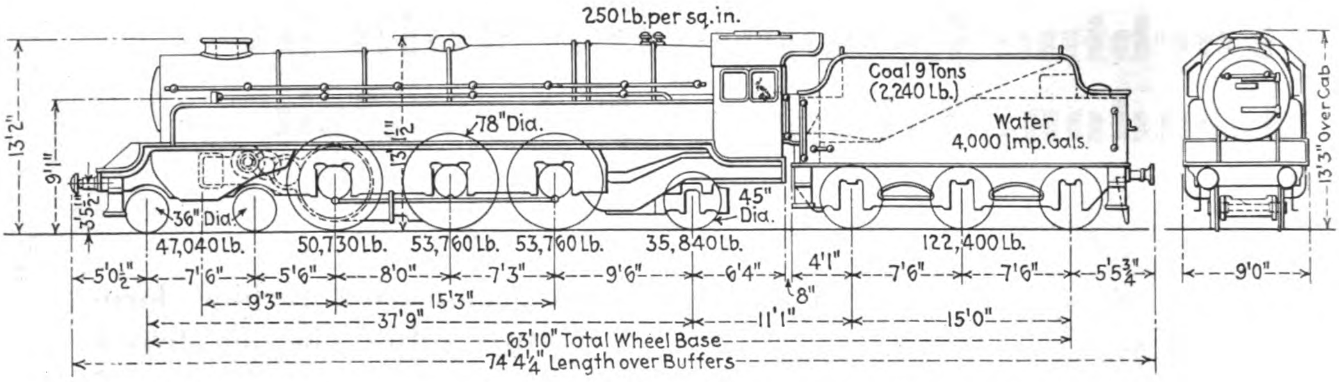
Similar Conventional Locomotives

Until recently the L.M.S. has employed 4-6-0 type locomotives in handling its heavy passenger traffic. In 1933, however, a design was worked out for a 4-6-2 type locomotive and two engines—Princess Royal, No. 6200, and Princess Rose, No. 6201, were built and placed in service. These locomotives had four single-expansion cylinders, 16¼ in. by 28 in., 78-in. drivers, 250 lb. boiler pressure, 40,300 lb. rated tractive force, and weighed 234,000 lb. in working order, exclusive of tender. The boilers had 2,713 sq. ft. evaporative heating surface, of which 190 sq. ft. was in the firebox and 2,523 sq. ft. in the tubes and flues. To this should be added 370 sq. ft., in the 16 superheater elements. These locomotives were designed to handle trains weighing from 500 to 560 tons (2,000 lb.) between London and Glasgow and permit a reduction in the running time of trains already noted for their high speeds.

These locomotives have submitted to many tests. As an example of their performance a test run made on June 27, 1935, may be cited. The train hauled, consisting of 14 passenger cars and a dynamometer car, weighed 508 tons light or 532 tons including an allowance for passengers. The run from Liverpool to London (Euston), a distance of 193.7 miles, was made in 3 hr. 20 min., including two stops at Crewe and Willesden, a total of five minutes. The run of 152.7 miles from Crewe to Willesden was made in 129½ min., including a number of slow-downs. This was at an average speed of 70.7 m.p.h. and a maximum speed of 86.6 m.p.h. Following the Liverpool-London run a dynamometer car test run was made from Crewe to Glasgow and return, a total distance of 486.6 miles. The train consisted of 20 cars and weighed 516 tons, exclusive of the passengers and luggage carried. On this section of the road there are a number of long grades ranging from 1 to 1.4 per cent. The average records for the Crewe-Glasgow runs gave a coal consumption of 52.6 lb. per mile and 47.1 U. S. gallons of water per mile. The coal consump-



Left hand side of L.M.S. non-condensing turbine locomotive—Control mechanism and piping are concealed by the housing above the running board

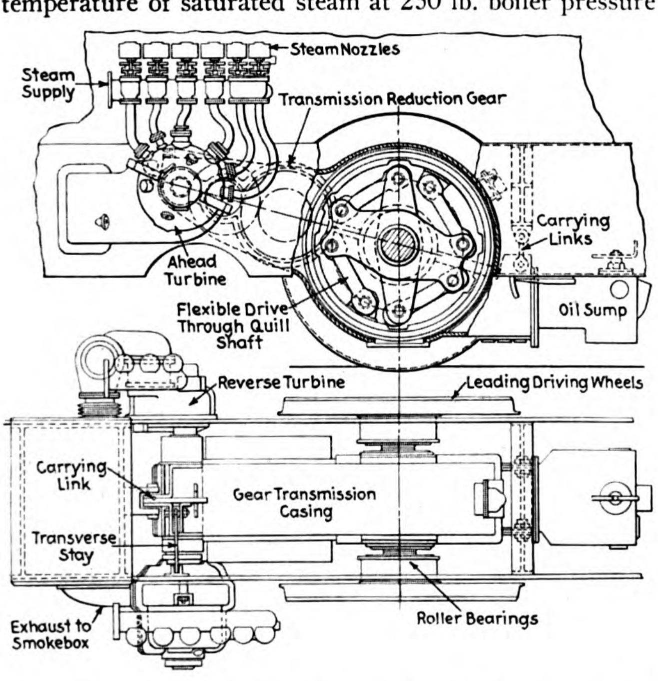


Elevation of the London, Midland & Scottish turbo-locomotive

tion per drawbar horsepower-hour was 2.88 lb. These rates are equivalent to 102 lb. of coal per 1,000 g.t.m. of train and an evaporation rate of 7.43 lb. of water per pound of coal.

Boiler Design Modified

After the highly satisfactory performance of the first two Pacific type locomotives built in 1933 orders were given for the construction of ten additional locomotives in 1935, which carry numbers 6203 to 6212, inclusive. The modifications made in the design at this time were slight, aside from certain changes in the boiler. A combustion chamber 43½ in. long was added which increased the firebox heating surface from 190 to 217 sq. ft. Instead of 170 tubes 2¼ in. in diameter and 20 ft. 9 in. long employed in the original boiler design, the number was reduced to 112 tubes, 19 ft. 3 in. long. The original boiler had, in addition, 16 flues, 5⅛ in. in diameter, while the new boilers have 32 flues of the same diameter. These changes reduced the tube and flue heating surface from 2,523 sq. ft. to 2,097 sq. ft. The superheater elements, which have an outside diameter of 1¼ in., provided 370 sq. ft. heating surface in the original design and 653 sq. ft. in the revised design. The first two boilers were designed to furnish steam at 550 deg. F. temperature, and the later boilers at 750 deg. F., the temperature of saturated steam at 250 lb. boiler pressure



General arrangement of turbines and reduction gear showing method of driving the leading axle

being 406 deg. F. From the changes described it will be noted that the volume of the firebox has been increased which should improve combustion and that the superheating capacity has been raised appreciably.

The boilers are of the Belpaire design, which is quite widely used in Great Britain, and the fireboxes are of copper. The firebox sheets are ⅝ in. thick and the back flue sheet 1 in. thick. The foundation or mud ring is level at the back and then slopes downward at the front. On the inside the firebox is 91¾ in. long, being 66¼ in. wide at the back and increasing to a width of 76⅝ in. at the front. The grate area provided is 45 sq. ft.

The distance from the bottom of the mud ring to the center line of the boiler is 82¾ in. at the front and 15 in. from center line to the crown sheet. At the back end the distance from the bottom of the mud ring to the center line is 74⅞ in. and from the center line to the crown sheet the distance is 11⅞ in.

The barrel and firebox wrapper sheets are of 2 per cent nickel steel. Welding, in addition to riveting, is employed on the seams of the wrapper sheet and along the longitudinal barrel seams for a distance of 12 in. from each end. Circumferencial barrel seams are welded at the bottom for a distance of 2 ft. on each side of the center line. Welding is also used around the corners of the mud ring and at several other points. Monel metal stays, ⅞ in. in diameter, 11 threads, are employed on the two outer side rows and on the top six rows and also in the curved portion of the throat. On the back head the top three rows are of copper, ⅞ in. diameter, 11 threads, and the balance are of mild steel, ⅝ in. diameter, 11 threads.

The boiler is fed by means of an exhaust-steam injector located on the fireman's side. This injector uses exhaust steam from the ahead turbine and discharges through a feedwater heater also supplied with exhaust steam from the ahead turbine. A live steam injector is provided on the other side of the locomotive.

The height of the stack above the top of the rail is only 13 ft. 3 in. and the width of the engine overall is 9 ft. The space permitted over the crown sheet is 2 ft. No steam dome is provided. The steam pipe is of the collector and dryer type, with inlet at the highest point above the back tube sheet. The throttle is incorporated in the superheater header.

The boiler used on the turbine locomotive, No. 6202, is the same as the later design employed on the ten conventional locomotives built in 1935. In running gear and in all other details possible the turbine locomotive is the same as on the others of the group so that comparative values may be obtained in service. The leading

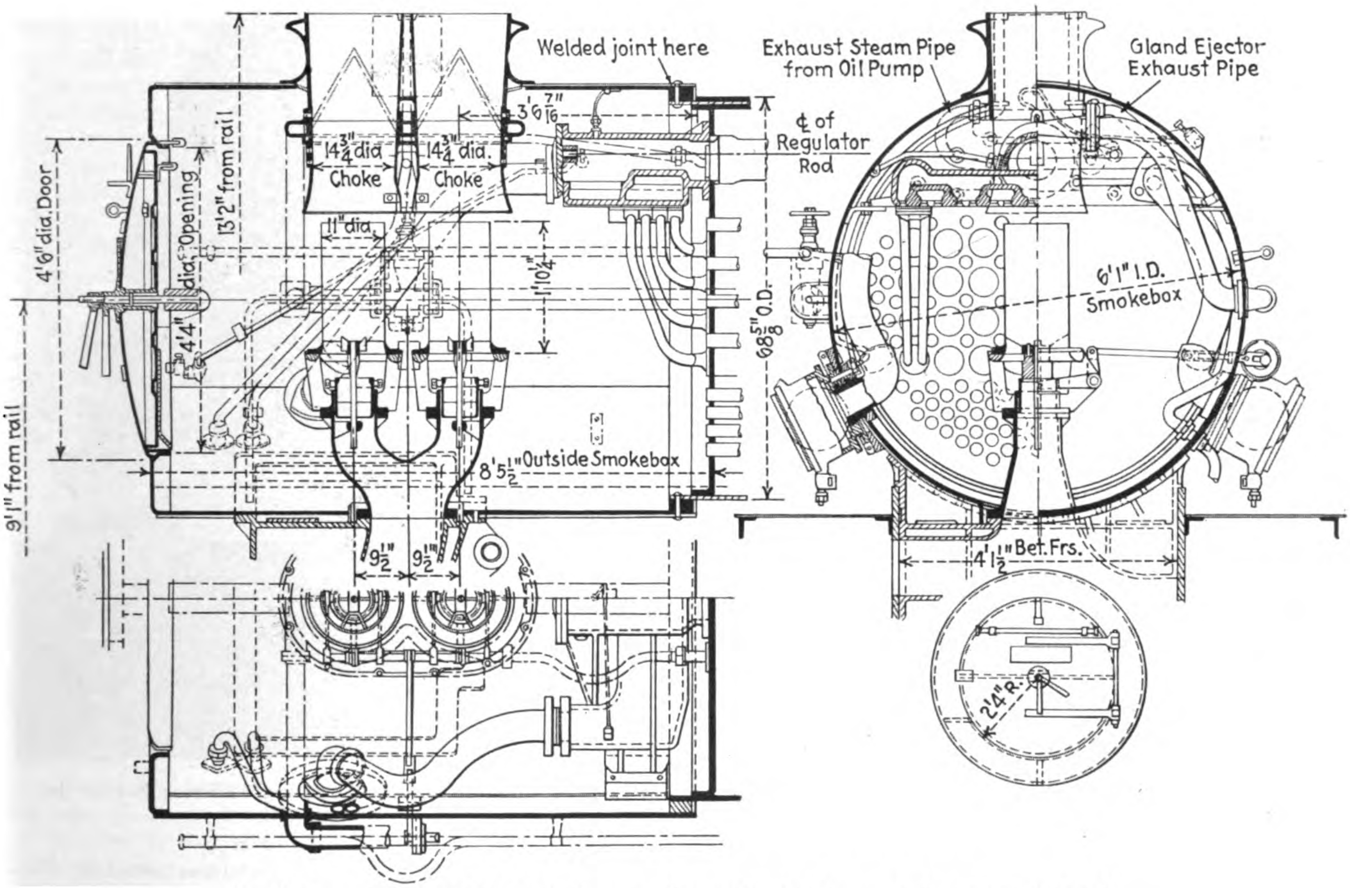
dimensions, weights and proportions of both types of locomotives are given in an accompanying table.

Turbines and Reduction Gear

The turbines are bolted to the outside of the plate frames at the front end, the ahead turbine on the left-hand side and the back-up turbine on the right-hand side. The turbine spindles are at right angles to the track or parallel to the locomotive driving axles. The ahead turbine is flexibly coupled to the high-speed pinion of the triple-reduction gear. The gear mechanism, which is of the double-helical type and enclosed in a fabricated gear case, is suspended from three supports on the engine frame, one at the front end and two at the rear. Provision is made in the first and second pinions for slight flexibility in order to equalize the pressure along the gear teeth.

In order to care for the vertical movements of the driving axle relative to the frame, the final drive from the low-speed gear to the leading driving axle is made highly flexible. Referring to one of the drawings, it will be noted that the low-speed gear encircles the driving axle and is coupled to it by a series of floating links. The gear has two opposite internal lugs to which links are attached. The free ends of these two links are connected to a large floating link which surrounds the axle. This floating link in turn is connected by two other links to arms which are a part of the driving axle shaft. The reverse turbine is provided with an additional single-reduction gear which is connected to the high-speed pinion of the main gear previously described by a mechanical clutch operated from the locomotive cab.

Steam from the superheater header, after passing through the main throttle valve, which is always kept open while the locomotive is in operation, is led to steam chests on the right- and left-hand sides in a manner similar to ordinary practice. Its passage from the steam chests to the various turbine nozzles is controlled by regulating valves operated from the control box on the left-hand side of the cab immediately in front of the engineman. The control mechanism itself is quite simple. There is a small horizontal panel with six numbered steps for operating the admission valves to the nozzles of the ahead turbine and three for the reverse turbine. There is also a clutch lever for connecting the reverse turbine, this being so interlocked that it cannot be moved except when the locomotive is standing still. To reverse, steam is first shut off and the engine brought to a stop by the brake. After this has been done the reverse turbine may be connected by means of a steam-operated clutch and steam then admitted to this turbine. When the locomotive is backing up, the ahead turbine revolves backwards. Both turbines exhaust to the atmosphere through double variable nozzles and a twin stack. A back pressure as low as 2 lb. per sq. in. is anticipated.



Smokebox of the L.M.S. turbo-locomotive with double, variable exhaust nozzle

All bearings on the turbines and the reduction gear, as well as the gear teeth, are mechanically lubricated, the oil being pumped from a well in the bottom of the reduction gear casing by a submerged pump. This is supplemented by a secondary steam-driven pump located outside and ahead of the gearing. This pump also provides means for circulating the oil through the cooler and may be operated while the locomotive is standing. The radiator for cooling the oil is located on the front deck ahead of and beneath the smokebox and is clearly shown in the front-end view of the locomotive.

Running Gear and Tender

The running gear is of the 4-6-2 type with 78-in. rod-connected driving wheels. The weight of the locomotive is 241,900 lb., of which 158,250 lb. is on the drivers, 43,000 lb. on the front truck, and 40,650 lb. on

the trailing truck. Timken roller bearings are used on the journals of all driving axles, leading and trailing-truck axles, and also on the tender axles.

The frames are of high-tensile steel plates, 1¼ in. thick. The load on the driving wheels is carried by underhung semi-elliptic springs. Each spring is independent; no equalized spring rigging such as is universal in American practice is provided. The spring plates are of silico-manganese steel. An easy spring movement is obtained by the introduction of auxiliary dampening springs between the frame brackets and the spring hangers. These dampeners consist of alternate layers of thin steel plate and rubber.

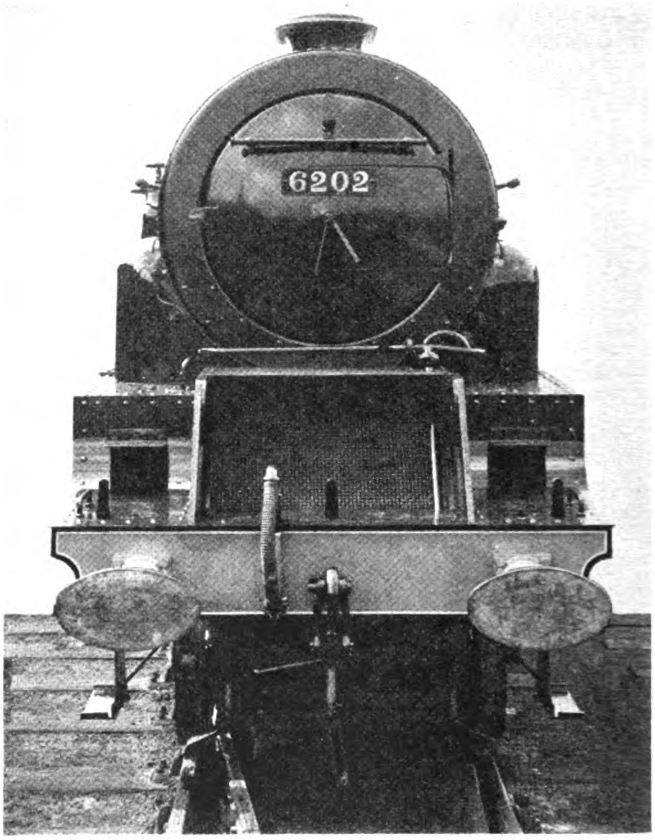
The tender, which is of the six-wheel type quite generally used on British locomotives, weighs 122,400 lb. loaded and has a capacity for 4,800 U.S. gallons of water and ten tons of coal. It is fitted with a water pick-up.

Dimensions, Weights and Proportions of L. M. S. Pacific Type Locomotives

	Four cylinder	Turbine
Railroad	L.M.S.	L.M.S.
Type	4-6-2	4-6-2
Road numbers	6203-6212	6202
Date built	1935	1935
Service	Passenger	Passenger
Height of stack	13 ft. 3 in.	13 ft. 3 in.
Width overall	9 ft. 0 in.	9 ft. 0 in.
Cylinders, diameter and stroke	4 — 16¼ in. by 28 in.	Turbine
Valve gear, type	Walschaert	......
Valves, piston type, size	8 in.	......
Maximum travel	7¼ in.	......
Weights in working order, lb.:		
Total engine	234,080	241,900
On drivers	151,200	158,250
On front truck	47,040	43,000
On trailing truck	35,840	40,650
Tender	122,400	122,400
Wheel bases:		
Driving	15 ft. 3 in.	15 ft. 3 in.
Total engine	37 ft. 9 in.	37 ft 9 in.
Total engine and tender	63 ft. 10 in.	63 ft. 10 in.
Length over buffers	74 ft. 4¼ in.	74 ft. 4¼ in.
Wheels, diameter outside tires:		
Driving	78 in.	78 in.
Front truck	36 in.	36 in.
Trailing truck	45 in.	45 in.
Boiler:		
Type	Belpaire	Belpaire
Steam pressure	250 lb.	250 lb.
Diameter, first ring, outside	68⅝ in.	68⅝ in.
Diameter at back tube sheet	75 in.	75 in.
Firebox, length	91¾ in.	91¾ in.
Firebox, width	73 in. to 66¼ in.	73 in. to 66¼ in.
Height mud ring to crown sheet, back	62⅞ in.	62⅞ in.
Height mud ring to crown sheet, front	82 in.	82 in.
Combustion chamber length	43½ in.	43½ in.
Tubes, number and diameter	170 — 2¼ in.	170 — 2¼ in.
Flues, number and diameter	16 — 5⅝ in.	16 — 5⅝ in.
Length over tube sheets	19 ft. 3 in.	19 ft. 3 in.
Grate area	45 sq. ft.	45 sq. ft.
Heating surfaces, sq. ft.:		
Firebox and comb. chamber	217	217
Tubes and flues	2,097	2,097
Total evaporative	2,314	2,314
Superheating	653	653
Comb. evaporative and superheat	2,967	2,967
Exhaust steam injector	Yes	Yes
Tender:		
Style	6-wheel	6-wheel
Water capacity	4,800 U. S. gal.	4,800 U. S. gal.
Fuel capacity (2,000 lb. tons)	10 tons	10 tons
Wheel base	15 ft. 0 in.	15 ft. 0 in.
General data estimated:		
Rated tractive force, 85 per cent	40,300	......
Cylinder horsepower (Cole)	2,375	......
Potential horsepower (Cook)	1,907	......
Speed at 1,000 ft. piston speed	49.70	......
Piston speed at 10 m.p.h.	201.2 ft.	......
Weight proportions:		
Weight on drivers ÷ total weight engine, per cent	64.6	65.4
Weight on drivers ÷ tractive force	3.75	......
Total weight engine ÷ comb. heat. surface	78.9	81.5
Boiler proportions:		
Tractive force ÷ comb. heat. surface	13.58	......
Tractive force × dia. drivers ÷ comb. heat. surface	1,059	......
Firebox heat. surface, per cent comb. heat. surface	7.3	7.3
Tube-flue heat. surface, per cent comb. heat. surface	70.7	70.7
Superheat surface, per cent comb. heat. surface	22.0	22.0
Firebox heat. surface ÷ grate area	4.82	4.82
Tube-flue heat. surface ÷ grate area	46.60	46.60
Superheat. surface ÷ grate area	14.51	14.51
Comb. heat. surface ÷ grate area	65.93	65.93
Potential horsepower ÷ grate area	42.35	42.35
Comb. heat. surface ÷ potential horsepower	1.55	1.55

Smokebox Arrangement

The smokebox on the locomotive has several unusually interesting features. The substitution of a turbine for a reciprocating steam engine necessitated a number of changes, as might be anticipated in view of the fact that the turbine exhaust is practically a steady blow and that the anticipated exhaust pressure is only two pounds. A



Front view showing oil-cooling radiator below the smokebox

double exhaust pipe and smokestack was adopted. This permitted the exhaust pipes from several of the auxiliaries to be carried up in the space between the two parts of the stack. The combination of the two stacks in a single casting has been well worked out and does not detract from the appearance of the locomotive. In order to assure the desired draft regardless of the number of nozzles opened to the turbine a variable type of exhaust nozzle is employed. As will be noted from the drawing the design used provides a central conical plug which is raised and lowered automatically as the amount of exhaust steam is increased or decreased. Straight petticoat pipes, 11 in. inside diameter, are employed. The inside diameter of the stacks at the point of choke is 14¾ in.

The operation of the turbines non-condensing has made it possible to greatly simplify the design as compared with that required for a condensing turbine locomotive. The method of controlling the turbine by several nozzles provides a wide range of flexibility and should assure a high economy.

Enginehouse Foreman Driven to Golf

Sad condition of affairs with too much leisure staring him in the face

[The recent discussion in our pages of the hardships under which many enginehouse foremen have to work has brought all sorts of comments and letters to the editor's desk. The saddest and most pathetic of all these is realistically expressed in the following communication from an enginehouse foreman, who is dismayed as he faces the problem of what to do with the leisure time that he will be compelled to utilize under changed conditions.—*Editor.*]

Three shifts for enginehouse foremen is something that should be viewed from every angle. For a starter, we "view with alarm" the paragraph on page 386 of the September, 1935, *Railway Mechanical Engineer*. Being very conservative, in the full sense of the word, we venture the opinion that the time is hardly ripe for three shifts. The thing will have to be worked out gradually, because, as we see it, the venture is fraught with perils galore.

Likely as not the enginehouse foreman going home at 3:00 p. m. under the new arrangement would be met and bitten by the family watch dog. He would no sooner get inside the door 'ere the neighborhood busybody would come visiting to inquire if the head of the house had come home sick, or just what was going on that would cause a man who had worked 12 hours a day over a period of years to "knock off" and come home in the middle of the afternoon—all of which would have to be explained more than once.

With all this newly acquired leisure "the bull of the woods" would undoubtedly be prevailed upon by his well meaning friends to take up golf. Not much of a strain is required upon the imagination to picture what a spectacle he would present in his golf togs—gaunt and stooped with knotty joints and bony legs, and one of those caps common to golfers pulled low on his brow, he ambles forth with the peculiar gait acquired by 20-odd years traveling about the circular course of a roundhouse in the necessary performance of his duties, and hereinafter referred to as "following up the work".

If he fares no better at golf than your correspondent at making hooks and slices and retrieving lost balls out in the "rough", it will bring forth a brand of language that will wither the grass in his wake.

Almost every one will agree that enginehouse foremen are not (collectively) an ungrateful lot and necessity requires that our newly made golfer make some iron shots. We vision him spitting out the turf that flew into his mouth, and you will probably hear him remark, "Thank goodness, they don't pasture cows on this grass."

Beginner's luck doesn't cut much of a figure with golfers, and our enginehouse foreman gone golfer would probably venture some opinions about the balls being out of counterbalance, thus causing those unusual curves. The clubs also will be under suspicion as to hidden defects that would cause or contribute to poor shots, and it is a dead ball that goes only 90 yards on the drive off, instead of the intended 275, etc.

About nine holes of this, with old Sol right out in front, isn't doing his neck any good, and evening will find him trying to reduce the burning on his back and soothe his aching joints as he lies back in his favorite chair with the old "hay burner" pipe and house slippered feet.

Domestic tranquility will prevail until Junior makes that great breach of etiquette, innocently inquiring, "How do you like golf, Pa?"

Go easy, boys, on this eight-hour day for the enginehouse foreman. It might get to be a national issue and get into the Supreme Court for a decision. That court might hand down a verdict, or just an opinion maybe, which when boiled down to ordinary talk would mean something about like, "It is hard to teach an old dog new tricks."

As I stated at the beginning, I'm a conservative and the best definition of a conservative that I have heard for some time was in one of the addresses at a purchasing agents' and stores meeting, wherein the speaker stated a conservative is one who is "not the last to discard the old nor the first to take up the new." With this thought in mind may I respectfully suggest that those contemplating the "New Deal" for enginehouse foremen, buy their golf togs, etc., on 30 days' trial, or 30 days "come and get 'em".

* * *

For explanation see page 88.

Fusible Drop Plugs On Southern Pacific*

THE use of fusible plugs in the crown sheets of locomotive boilers goes back to an early date and at one time the practice was quite general. In the most common form the plug consisted of a shell with a central hole about ½ in. in diameter which was filled with a composition of lead, tin and other metals, having a low melting point. Due to changes which took place in the soft metal after long exposure to heat and due to the formation of scale on top of the plugs, they often failed to function when low water permitted the crown sheet to be subjected to a higher than normal temperature. As a consequence railroads generally lost confidence in them and but few roads continued to apply them.

Believing that the theory of the fire-actuated fusible plug was sound in principle, the Southern Pacific carried on a research to develop, if possible, a plug of satisfactory design. As a result of the investigation and experiments a design was adopted in 1915 in which the plug was provided with a central steel button ½ in. in diameter held in place by fusible metal in a hole .002 in. larger than the button.

In the latter part of 1931 further improvement in the design and manufacture of this drop plug was made with a view to obtaining the objective that, when the plugs fused, the fire would be so interfered with that it would be difficult and perhaps impossible, for anyone to continue to manipulate any device that would continue the operation of the locomotive under such conditions. The drop plug thus designed and perfected is shown in one of the illustrations.

In general appearance the plug is similar to the original design, but particular attention is invited to the dimensions governing the application of the button. During the period when the new plug was being developed, the conclusion was reached that the diameter of the button should be enlarged from ½ in. to ⅝ in. This change increased the area of the opening 56 per cent. The reason for doing this was to increase the load on the button at a given boiler pressure, so that the button would drop out of the plug in the event the boiler was fired up without sufficient water over the crownsheet and full boiler pressure had not yet been reached.

A further advantage of the ⅝-in. diameter opening in the plug is that much more steam will be admitted to the firebox when the plugs fuse. Experience with the ⅝-in. opening has shown it to be of ample size, for in cases of low water it has been found that the sheet in the vicinity of the plug location is not discolored and bears no evidence of having become overheated.

It was also considered necessary to increase the thickness of fusible metal between the button and the plug body. The original plug had 0.001 in. thickness of fusible metal. The reason for this increase was that oxidation has a deteriorating effect on the fusible metal and the more rapidly the fusible metal is heated and cooled down the more rapid becomes the process of oxidation.

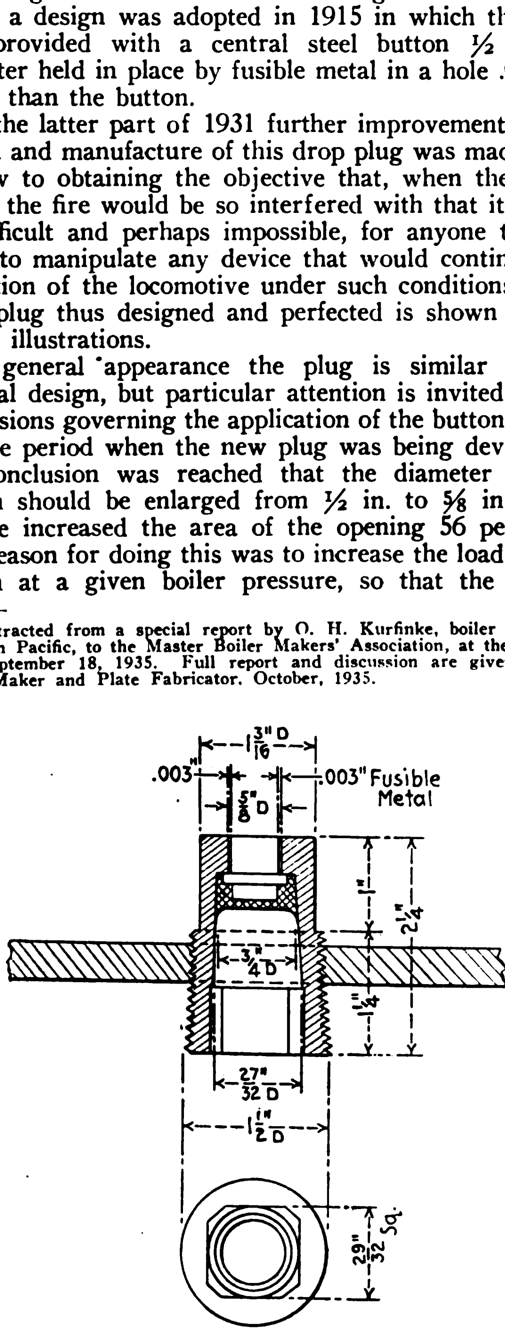
As these drop plugs fuse due to a rise in temperature through the plug body, the larger the button diameter (of course within certain limitations) the more rapidly the plug will function under the same boiler pressure. For instance, when the heat gradually increases the fusible metal will begin to soften and, when it reaches a certain degree of softness, the pressure on the button will force it out of the plug body. Where a boiler is fired up without sufficient water and pressure in the boiler is very low, the thickness of fusible metal is such that it will melt to a liquid state and, in so doing, the button will fall out at the first indication of a load upon it. As the pressure gradually increases and the plugs fuse in multiple, the hazard of accident is less likely, since the higher the pressure becomes the greater also becomes the volume of escaping steam. Within a short time the disturbance thus created will direct the attention to the fact that something is wrong.

From the foregoing one can easily visualize the effectiveness of the button-equipped drop plug compared with the solid alloy-metal fusible plug and the improvement in the design of the drop plug as compared with the original design.

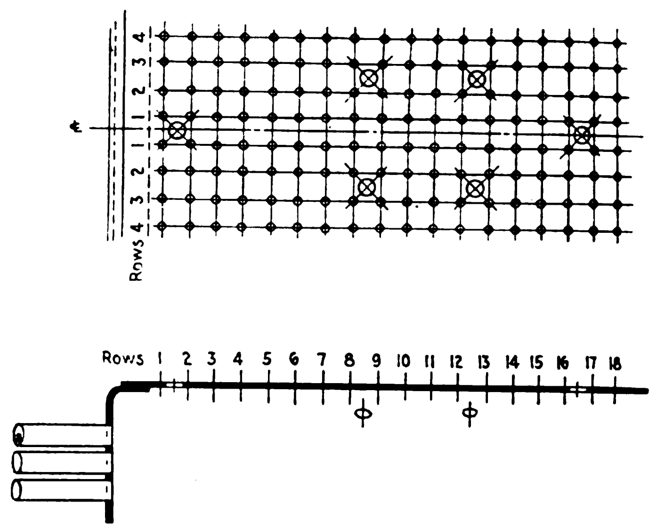
Our experience satisfies us that our locomotive boilers have increased in size beyond the capacity of one or two plugs, as we have had cases where these large boilers can continue to be fired and the engine worked against the blowing of two drop plugs.

To overcome this it was necessary to equip large fireboxes with an increased number of drop plugs to obtain an effect similar to that of the sprinkler systems so successfully used in large buildings, which release a spray of water automatically in case of fire. Such an

* Abstracted from a special report by O. H. Kurfinke, boiler engineer, Southern Pacific, to the Master Boiler Makers' Association, at the meeting held September 18, 1935. Full report and discussion are given in the Boiler Maker and Plate Fabricator. October, 1935.



Drop plug for crown sheets of S. P. locomotives



Location of drop plugs in large crown sheet

application of drop plugs is termed a multiple application. The second illustration shows a plan view of the crownsheet of a locomotive firebox with combustion chamber having 513 sq. ft. of heating surface and a grate area of 139 sq. ft. The number of drop plugs—viz., six—is based on the application of one plug at the highest point of the crownsheet between the first and second rows of stays and one additional plug for each 400 sq. in. of gas area of the flues, so located that the main group or the majority of these plugs are in the crownsheet directly over the hottest portion of the firebox.

C. & O. 4-8-4 Locomotive

(*Continued from page 48*)

and down to the bottom of the mud ring on the other side, the throat seam to the third sheet course is completely seal welded, the longitudinal boiler seams are seal welded at each end for a distance of 12 in., and the outside butt-strap on the third course longitudinal seam is seal welded in the stayed zone of the combustion chamber. In addition, the combustion tubes are seal welded on the fire side, all tubes and flues are welded at the firebox end and the staybolt MK caps and UW sleeves are welded.

The cylinders are 27½ in. in diameter by 30 in. stroke. With 250 lb. boiler pressure and 72-in. drivers a rated tractive force of 66,960 lb. on an 85 per cent basis is thus provided. A Franklin type C-2 long cutoff booster with slip control and check valves is applied to the trailing truck. This adds 14,075 lb. to the tractive force, bringing the total for the main engines and the booster up to 81,035 lb. The exhaust from the booster is piped to an integral passage cast in the front side of the smoke stack.

The two cylinders, spaced on 91½-in. centers, are annealed carbon-steel castings of the half-saddle type with 14-in. piston valves having a maximum travel of 7½ in. The steam lap is 1⁹⁄₁₆ in., the exhaust clearance ³⁄₁₆ in., and the lead ¼ in. Steam and exhaust passages are direct and of large area to reduce the losses due to drop in steam pressure and back-pressure resistance. Flextite steam pipe casings are provided. The back cylinder heads are separate castings. Conventional bolting of the cylinder castings is supplemented by electric welding at the saddle splice joint and at the frame fits. The valves are operated by Walschaert gear under control of an Alco type E reverse gear. The crossheads and guides are of the multiple-bearing type.

The frames are of the bar type, each a separate annealed carbon-steel casting and joined together by the conventional type of transverse cast-steel bracing, with a cast-steel deck plate at the front and a steel cradle casting under the firebox. The pilot is of the cast-steel type and provided with a pocket into which the front coupler may be dropped when not in use.

The first, third and fourth driving axles have 11⅞-in. by 13-in. journals on the left side and 12-in. by 13-in. journals on the right side. The second, which is the main driving axle, has 12⅞-in. by 13-in. journals on the left side and 13-in. by 13-in. journals on the right side. This difference of ⅛ in. in right- and left-hand journals on the same axle is in accordance with the general practice on the C. & O. and permits of shifting crown brasses from one side to the other as wear takes place. This same practice is also applied to crank pins. All axles, crank pins and rods are open-hearth carbon steel forgings, normalized and annealed. The Alco lateral cushioning device is applied to the front driving boxes. The locomotives are fitted with tandem main rods operating on the crank pins of the second and third pairs of wheels. This design of side rods requires no knuckle pins.

All axle journals, crank pins and guides have been provided with ample bearing areas so that all bearing pressures on these locomotives and tenders are exceptionally low.

The four-wheel leading truck is of the General Steel Castings constant-resistance rocker type, with inside journal boxes. The four-wheel trailer truck is of the Delta type.

Force-feed lubricators furnish oil to the guides, the steam chests and cylinders, the engine truck boxes, the air pumps and the hot-water feedwater pump. The mechanical lubricators on three of the locomotives are the Detroit 32-B type, and on two, the Nathan 24-pint, 16-feed type. A three feed, three-pint hydrostatic lubricator is provided for the booster and the stoker engine.

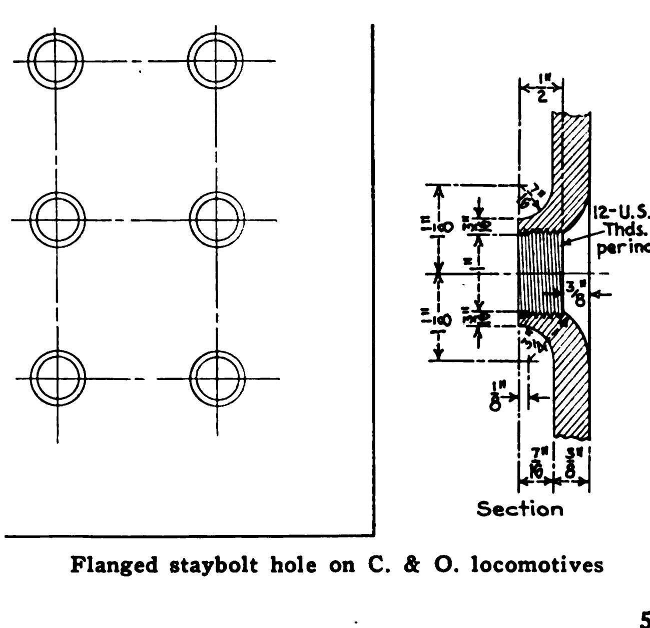
The locomotives are provided with New York No. 6-ET brake equipment, including two 8½-in. cross-compound air compressors, mounted on the front deck on brackets extending under the front end of the smokebox. They are equipped with the Union Switch & Signal Company's intermittent induction type train control.

The rectangular water bottom tender has a capacity for 25 tons of coal and 22,000 U. S. gallons of water. It is carried on two Buckeye type, six-wheel trucks and has a loaded weight of 381,700 lb. The stoker engine is housed in the left side of the tender in a compartment set in the front water leg. The Franklin Unit Safety drawbar and the type A-1 Radial Buffer are provided between the engine and tender. Simplex brakes are applied to the trucks.

Flanged Staybolt Holes on C. & O.*

THE Chesapeake & Ohio is experimenting with flanged staybolt holes for firebox sheets which it is anticipated will add flexibility and reduce the danger of cracks starting from such holes. Two locomotives have thus far been equipped. Both have completed one-half of this mileage cycle and thus far no staybolts have required repair until the engines were shopped.

* From a discussion at the September, 1935, meeting of the Master Boiler Makers' Association.



Flanged staybolt hole on C. & O. locomotives

EDITORIALS

What Do You Want to Know?

In the United States today there are in the neighborhood of 200 Diesel-powered streamlined trains, rail cars and locomotives. Every one of these constitutes a problem for someone in the railroad mechanical department that cannot always be solved by the experience gained by many years of association with steam power.

With the idea of serving our readers who may want to know things about Diesel power but who have no specific place to go for the answer the *Railway Mechanical Engineer* introduced into the December, 1935, issue a column of "Questions and Answers." From letters we have received it is apparent that many of our readers would like to see such a column continued. Therefore, in order to provide some incentive for readers to jot down the questions which come to mind and send them in, we are offering the payment of one dollar ($1.00) for each question on this subject which is accepted for publication. The questions should be mailed to the office of publication, 30 Church Street, New York.

Turbine Locomotive Given Another Chance

The steam turbine has shown itself to be such a highly efficient prime mover in the stationary and marine fields it was but natural that locomotive designers should endeavor to employ it also in their field. During the past fifteen years the turbo-locomotive has not only been given a theoretical consideration, but a number of such locomotives have been built in Italy, Switzerland, Germany, Sweden and England which were known by the name of their proponents—Belluzzo, Zoelly, Krupp, Ljungstrom and others. Most of them were described in earlier issues of the *Railway Mechanical Engineer*.

The thought of high efficiency, commonly associated with the steam turbine, is obtained only under certain limiting conditions. A constant and suitably high rotative speed must be employed, a high exhaust vacuum must be attained, and the unit must be of a relatively large size. Its starting torque, at least in most designs, is low and it is non-reversing so that its best performance is under conditions where long runs can be made without shut downs. Moreover, if the power is to be taken off at a rotative speed less than that of the turbine spindle, a reduction gear must be employed. Fortunately, it has a large capacity for its weight and the space occupied, while reduction gears have reached such a high degree of development that they are now a minor problem.

Due to the restrictions mentioned the application of a steam turbine in place of a reciprocating engine to a locomotive has presented a difficult problem. Most of those who tackled the problem were, naturally, men experienced in the stationary field. In their endeavors to improve the efficiency of the locomotive they, naturally, sought to incorporate in it various devices, such as condensers, feedwater heaters and pumps, air preheaters and exhaust fans. Of these auxiliaries the working out of successful designs for condensers and exhaust fans proved to be extremely difficult. Condensers with air-cooled, as well as water-cooled, surfaces were tried. They were complicated, expensive and of varying capacity, dependent upon weather conditions. Moreover, available tender space was limited. As a consequence of high initial costs, increased complications and added maintenance expenses, considerably in excess of any demonstrated savings in fuel and water, most practical railroad men lost interest and the turbo-locomotive failed to become more than a fascinating engineering problem. It is of considerable interest, however, that a few of the more recent turbo-locomotives constructed were of the non-condensing type. These gained in simplicity, although they were somewhat less efficient.

At this discouraging stage the mechanical officers of one of the most important and progressive of the British railroads became convinced that the time had not yet arrived for pronouncing the turbo-locomotive a failure. They, therefore, attacked the problem of designing a turbo-locomotive which would be as simple as possible and yet permit the realization of a large portion of the turbine's efficiency. The result of these efforts is the London, Midland & Scottish locomotive described elsewhere in this issue.

This is a railroad man's idea of a clean-cut locomotive with no more departure from good standard practice than was required to apply a turbine in the place of a reciprocating engine. In working out the design, however, the accumulated knowledge of an experienced staff of a turbine and reduction gear manufacturer was utilized. In boiler, running gear and many details the locomotive is a duplicate of the latest and most successful 4-6-2 type standard locomotives built by this railroad. As a consequence, the results obtained in service will be fully comparable. It will be noted from the description that the locomotive is non-condensing, easily and efficiently controlled, and that an extremely ingenious front end has been worked out which it is an-

ticipated will make the resort to an exhaust fan unnecessary. The anticipated fuel economy is reputed to be 15 per cent which, if realized, would amount to a considerable reduction in operating costs in a country where current costs of coal may be taken as approximately $4.25 per ton.

Alloy Steels and Light Weight

The marketing of low alloy structural steels for use as a means to reduce dead weight and increase the life of railway rolling stock is a development which the railroads have sought for several years. During that time the steel manufacturers were encouraged, even urged, to produce a structural material of greater strength than carbon steel, which would not depend for its improved physical properties on special heat-treating processes, in order that the growth in the burden of dead weight in railway equipment could be checked and reversed.

The producers of structural steel have, in general, been interested in producing a low-priced tonnage product. The laboratories, of which there are no lack in the industry, have been for many years devoting themselves mostly to the improvement of processes by which the cost of carbon-steel products could be reduced and the quality improved. The industry has not been noted for its interest in the development of new materials which would interfere with the established routine of its carbon-steel tonnage production.

During the last three or four years, however, this situation has changed and an active interest has become evident in the discovery and development of alloys which can be produced in quantity at commercially feasible prices. Such are the so-called intermediate steels which, in addition to their increased strength, possess materially greater resistance to corrosion.

Now that materials are offered to meet the desires of the railways for a reduction in dead weight, a number of freight cars have been built in which the new materials have been employed in the principal elements of the structure. The fact that the pound price of these materials is higher than that of the carbon steel which they replace has aroused widespread interest in the problem of determining the dollars and cents value of each ton of weight which may be removed from the tare weight of the cars. Several such formulas have been developed.

It is obvious that at some price per ton of saved weight the increased cost of the light-weight cars may be sufficient to offset the value of the reduced weight in terms of lower operating expenses. Considered by itself, however, no one will deny that a saving of three, four or five tons in freight-car tare weight will produce distinctly worth while reductions in operating expenses. Even though at the outset the price which must be paid for equipment so constructed may leave a questionable margin of return, it must not be overlooked that the possibility for the reduction of car prices to a point little, if any, above those which must now be paid for cars built of the customary carbon steel shapes and plates depends upon the volume in which the use of the new materials develops. Already new mills are being installed for the rolling of some of these new materials and changes in dies and other details in the technique of fabrication on the part of the builders will undoubtedly have their bearing in reducing construction costs, not to mention designs better suited to the new materials.

With the relatively narrow margin of increased cost per car by which several tons of tare weight can now be traded for revenue load, the railroads may go ahead with the employment of the new materials confident that the saving in weight in the equipment purchased over a four- or five-year period will add little, if anything to the average price per car unit.

Romance of Electrical Developments on Railroads

In these days of rapid development along technological lines we are inclined to take things too much for granted and to forget the simple conditions under which our grandparents lived. This is forcefully brought to mind by the fact that the Westinghouse Electric & Manufacturing Company celebrated its fiftieth anniversary early in the month of January. It was not until the latter part of the 80's that the first street railway electric trolley system was built. If we only go back as far as the beginning of the present century—three and a half decades, and within the memory of most of our readers—and review the applications of electricity on the steam railroads since that time, we can get some idea of the tremendous progress which has been made in even that brief period.

In the latter part of the last century the general lighting in railroad shops was by flickering arc lights; low-power, pendant, incandescent lights (yellow strings in bottles) were used at the benches and machines. The old oil torch was an essential part of the railway mechanic's equipment. It is said that people who lived in Pittsburgh for even a short time, before the smoke elimination campaign was effective, could be identified after death by the fact that an autopsy would show a marked discoloration of the lungs. It is interesting to surmise what an autopsy would show in the lungs of a railway mechanic who attempted to do close work in the locomotive erecting shop and enginehouse with the use of the old-fashioned, smoky oil torch. These conditions are in marked contrast to those of the present day, when special lighting fixtures

and devices are used throughout the shop and enginehouse, in order to add to the convenience and comfort of the workers and make possible more efficient production and more accurate work.

Portable electric tools were practically unknown and the dinky portable steam engine, with its unwieldy flexible shaft, was hauled around the shop and connected up to steam lines for driving a limited number of tools, including the cylinder boring bar. Today, all sorts of portable, electrically driven tools are available, which can readily be plugged in and operated anywhere in the shop. Electric cranes, hoists and trucks speed up the handling of material and parts.

At the beginning of the century experiments were being made in a limited way with the application of the motor to individual machine tool drives. Today, line shafting, with its countless unsightly belts and shifting devices, has been largely done away with. The application of the individual motor drive to machine tools focused attention on speeding up production and making the very best use of the new cutting steels which were beginning to come into use. Possibly the greatest gain from the application of the individual drive has been the fact that machine tools can be located in any position. This has made possible the speeding up of production, since operations can be scheduled in the proper sequence, with the least possible waste motion between the various operations.

Electric welding has revolutionized repair processes. Heat treating by the use of electrical furnaces has made possible the accurate tempering of tools, and has taken the guess out of the preparation of babbitt for bearings.

Improvements such as those noted have also almost completely revolutionized enginehouse practices and have made possible a number of important improvements which contributed materially to the better functioning of these terminals. The old-fashioned, slow, and inefficient turntable has been succeeded by the fast operating, substantial, modern motor-driven table.

Oil headlights and cab lights on the locomotive have been replaced with electric lights, which have contributed to the more convenient and efficient handling of the locomotives. The early applications of electricity to the operation of signals were looked at askance by the average railroader, and it did take considerable time to improve these devices so that they would function with reliability—today they are one of the most important and reliable factors in the efficient operation of our railroads.

Oil lights and gas lights have almost disappeared from our passenger cars, although at the beginning of the century electric car lighting was in its infancy and was being experimented with on a few cars, most of them business cars. Mechanical department officers of that period, if they are still alive, can still recall with fear and trembling their experiences with some of the officers upon whose business cars electric lighting apparatus was being tried out. Today, the use of electricity upon the most modern passenger cars leaves little to be desired in the way of reliability or of effective lighting. Moreover, electrical devices play a large part in most of the air-conditioning apparatus on passenger cars and on various other devices on passenger trains, including boilers, radio, etc.

At the beginning of the century the electrification of railroads entering New York City was being considered and there was a royal battle on between the exponents of the alternating and the direct-current systems. Those who attended the electrical meetings of the New York Railroad Club in those early days still chuckle as they recall the vehemence with which the speakers expressed themselves, the only agreement between the opposing factions in the electrical field being that the steam locomotive would disappear within a decade. Electrification of trunk line railroads has gone on over the years, where it could be utilized to distinct advantage, so that today we find a considerable number of such applications. But the steam locomotive is still carrying the brunt of the load. It is significant, however, that the year 1934 showed the completion of the Pennsylvania electrification from New York to Washington, thus making possible faster service of the heavy traffic trains which operate between those two cities.

We might go on at great length to compare conditions in the railroad offices of the year 1900, with those of today, in which electrical appliances of all sorts play such a large part. Space is not available, however, to explore into these other departments and into other phases of railroad operation. The electrical companies with their engineering and research departments, are to be warmly congratulated for their remarkable contribution to railway efficiency and economy in the few decades during which these applications of electricity to the railroads have been in process of development.

NEW BOOKS

POWERFUL 4-8-0 TYPE FRENCH LOCOMOTIVES. *By Andre Chapelon. Published by H. Dunod, 92 Rue Bonaparte (VI), Paris. 160 pages, 12 in. by 8¼ in., paper binding. Price 34 fr. 20.*

This pamphlet, which is a reprint of articles which appeared in the Revue Generale de Chemins de Fer, contains a very complete description in French of these remarkable locomotives now in service on the Paris Orleans-Midi. Many illustrations and six large folded plates add to its value. The reasons for various details of the design, the results obtained in service, together with dynamometer car and other test data are given in detail by the author, who was responsible for the design. These locomotives are 4-cylinder compounds with poppet valves. By use of high steam pressure, high superheat and careful designing of steam and exhaust passages, together with a double exhaust system, a design was produced which has shown such high efficiency in operation as to attract world wide attention.

THE READER'S PAGE

Fitting Floating Rod Bushings

To the Editor:

I noticed in the October issue of the *Railway Mechanical Engineer* the report of the meeting of the International Railway General Foremen's Association. One general foreman, in discussing the fitting of floating rod bushings, said a good practice is to allow .003 in, per inch of diameter smaller than the stationary bushing and .0005 in. per inch of diameter larger than the pin. This would give, on a 13 in. diameter, an outside clearance of .039 in., and an inside clearance of .006 in., or .045 in. total clearance. I think this is too much clearance on the outside diameter and not enough on the inside diameter. I have followed a practice, which has given good results, of making the bushing .015 in. smaller than the rod fit and .015 in. larger than the pin fit on all sizes of floating bushings. I cannot remember having any bushing stick in the rod or onto the pin; they last a long time. We had one floating bushing that was applied on a Mountain type passenger engine on October 30, 1930, and was renewed October 30, 1935; of course, this bushing made a lot of miles in that time.

In fitting stationary cast-iron rod bushings for the floating bushing I make them .020 in. larger than the hole in the rods and bore them .007 in. to .010 in. taper and, when they are pressed into the rods, you have a straight round hole. If the general foreman should try my practice of making floating bushings, I don't believe he would have any rod knocks. I very much fear that .039 in. will cause a noticeable rod knock.

W. E. Howard.

A Plea for Separate Journal Boxes

To the Editor:

That the freight-car truck with journal boxes and side-frame cast integral is growing in popular favor is apparent from the large number of such trucks that are now in service. In fact, this type of truck appears to be universally used on the cars built in recent years.

It is recognized, of course, that with the integral frame some saving in maintenance expenses is no doubt realized because of the fewer truck details. For example, there are no box bolts, nuts, washers, etc., to worry about, the absence of which, some equipment officers contend, facilitates inspection in transportation yards and reduces replacement expenses. While all this may be true, the question arises, is this sufficient to justify the adoption of the integral frame?

Assuming that box-bolt maintenance is an item of expense, is it not a fact that this expense is nullified by the labor saving realized in the time consumed effecting wheel changes? It would be interesting indeed to ascertain why certain engineers favor the integral type frame. Of particular interest would be a discussion of such matters as the future disposition of integral frames where the journal-box ceilings and dust-guard wells are found worn; also the relative cost of wheel changes with integral and non-integral frames.

In this connection there is the question of economy to be considered respecting the use of serviceable second-hand journal boxes recovered from dismantled equipment with the non-integral type frame. It is this writer's observation that the non-integral frame of proper design has certain definite advantages which can not very well be overlooked. Upon a careful investigation it may be found that the economies claimed for the integral frame are over-emphasized.

A Car Man.

And He Reads the Railway Mechanical Engineer!

To the Editor:

Knowing not your curator of ornithological exhibits, I rush to you with my complaint. The *Railway Mechanical Engineer,* December, 1935, page 495, credits James Nichols with the finding of a nest of the golden plover —at Dubuque, Iowa, no less. 'Tis the first time in history, I believe, the golden plover has ever nested at Dubuque—and even the first time anywhere in the United States. Records indicate the golden plover regularly nests from Pt. Barrow along the Arctic coast to Melville Peninsula and probably west to Baffin Island, north to Melville and N. Devon Islands, and south to Ard Lake and Chesterfield Inlet. Rand-McNally places Dubuque far outside these limits.

And the tail of the golden plover (commonly known as Pluvialis dominica dominica) is usually considered to be brownish gray, indistinctly barred, and not yellow.

There's no chance for disagreement as to the streamlining of the chicks; birds (blunt at the front and tapering away) are among the originators of streamlining.

Yours in the interest of ornithological accuracy.

(Signed) X.

PS:—I've a hunch Mr. Nichols found the nest of the killdeer.

Romney, Hythe & Dymchurch Railway

To the Editor:

In his explanation of the cartoon printed on page 511 of your December number, Marinac says that "this little railroad . . . could lay a double track between the rails of a standard track." That is quite true, but it would not be possible to run trains simultaneously on a double line so laid, because the passenger cars of the R. H. & D. Railway are 3 ft. 6 in. wide overall.

Incidentally, Marinac's cartoon does not convey an adequate idea of the motive power of this railway. The two latest 4-6-2 type locomotives weigh 19,600 lb. in full working order, including tender. They are 5 ft. high, from rail to top of stack, and 28 ft. 5½ in. long overall. The earlier 4-6-2 and 4-8-2 type engines are only slightly smaller. Though the Ministry of Trans-

port prescribes a speed limit of 25 m.p.h. for this line, the steam locomotives have approached 40 m.p.h. on special occasions. The engineman is not exposed to the extent shown in the cartoon.

WM. T. HOECKER.

Marinac vs. Mechanical Engineer

TO THE EDITOR:

Noting letter signed "Mechanical Engineer" in your issue of December, I think some of your readers may still be puzzled.

Which is the westbound rail of an eastbound track; or which is the eastbound rail of a westbound track?

Artists are customarily allowed rather large tolerances, but mechanical engineers in railway work usually are called upon to operate in precision.

Your readers probably know what Marinac meant, and some may know what "Mechanical Engineer" meant. Of the two, it would seem that the latter errs the most.

EXECUTIVE.

Which Comes First—The Job or the Rule?

TO THE EDITOR:

When visiting at the house of a friend, I happened to pick up the October issue of the *Railway Mechanical Engineer* and, being an ex-subscriber and an old railroader "hoping for a pension," I reverted to my old habits and immediately turned to those always interesting pages of "letters to the editor."

On page 423 there is related an astonishing episode between a roundhouse foreman and his superintendent of motive power. After reading it I looked twice at the date on the cover, for it read more like a page from an old edition published about 1886 than one in the year 1935.

In my younger days there would have been no necessity for asking such a question as "What would you have done?" In fact there was only one way to answer it, and that was by the good old-fashioned method and may the best man win. It was always a survival of the fittest and neither mental nor physical superiority alone would suffice. It required a combination of both to keep on top. It would be of interest to me, and I am sure to other readers also, to know just how long that superintendent lasts.

Admitting that it is a dangerous procedure to allow the ruling against intoxication to be violated, it is my belief that the foreman used good judgment in reasoning that the job to be done was of more importance than the violation of a rule. Surely efficient transportation and duty to the public comes first with every railroad officer and, if by stretching a rule better service can be maintained, my idea is to stretch it to the limit.

How many of us would almost embrace the old-time boomer mechanic who had just dropped off a freight and was still shaky from a previous debauch. We knew it was against the rules to hire him, also that he would not be with us long, but what a help he was while with us!

But to stop reminiscing and deal with the subject; what about the wonderful organizations, co-operative movements and adjustment committees on our railroads we have read so much about? Have they gone the way of the boomer, too? Or is it that when these bouquets were handed out, the foremen were forgotten? I believe Mr. Superintendent would think twice before dealing in such an arbitrary manner with any of the organized trade groups, knowing that in an appeal it might show cause for criticism of him for allowing one or two other conditions to exist that the writer of the article describes.

Show me a successful roundhouse foreman who does not violate a rule, or, in railroad terms, "take a chance." Believe me, if he didn't, he would not be a foreman long. If I had been that superintendent, I never would have known, officially, anything about that particular incident and would have kept that foreman in mind for the first promotion vacated.

OLD TIMER.

What Would You Have Done?

TO THE EDITOR:

I would like to make a suggestion about the little enginehouse drama entitled, "What Would You Have Done," that was published in the October, 1935, number of the *Railway Mechanical Engineer*. There was also some comment on it in your December issue, page 517.

I imagine something like the following flashed through the S. M. P.'s mind after hearing Bill Jones' explanation. There must have been outstanding thoughts bursting through his consciousness:

"Loyalty! Co-operation! Understanding!"

Loyalty of the man who would come back on the job, knowing the danger of being discharged for being intoxicated, and yet knowing that his particular knowledge of that night's work was especially needed if the engine was to be finished on schedule.

Co-operation on Bill's part in shielding his man because it was his first offense, loyally trying to show his *understanding* and appreciation for the efforts this man used in his behalf.

It took but a few moments for these thoughts to fly through the S. M. P.'s head—the realization of the work accomplished by these men that went into the making of a big railroad organization—and he knew there were other men like Bill, who though handicapped from the loss of man-power, were still serving their railroad with the same unswerving loyalty.

So turning to Bill, the S. M. P. said: "Go back to your job, Bill. You are a better man than I, for you have taught me a lesson that I've needed to know."

And again those three words flashed through his mind: Loyalty! Co-operation! Understanding!

A READER.

PERHAPS CARS WILL BE OF STEEL.—A 65-year-old copy of the Official Guide recently dug up contains the following prediction: "The time is not far distant, probably, when passenger cars will be made of iron or steel, and that without any increase of the non-paying weight. The iron car will have the advantage that it cannot be burned and the passengers cannot be transfixed with splinters in case of collision. There have already been one or two iron passenger cars built in this country, but they were crude in design and not looked upon favorably either by managers or by the public."

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Smash and Clash and Rattle

I have saved the article on ways and means of reducing noise around passenger cars (January, 1936, page 24). . . . One of the few remaining annoyances about travel in modern railroad cars is the disposition of the running gear to smash and clash and rattle sometimes.

Suggests Change in Seniority Rules

The seniority regulations should be changed to read: "Seniority shall prevail *only* when qualifications and merit are equal." This rule should be strictly enforced. In applying this, the management should be the judge, but the employees' representative must agree to the decision and give the employee the privilege of comparing qualifications in conference, if he so chooses.

Visiting Other Shops

I dare say there are lots of foremen in and around terminals where the company has main shops and nothing is being done in the way of giving these foremen an afternoon now and then to pay the shops a visit and see the construction work going on, be it pipe work, carpentry, upholstery, or whatever a man may be interested in, in general and particular. Moreover, I feel sure that the time is near at hand when railroads will have to demand a fairly high standard of education in their employees.

Our Efforts Fruitful

The officers and members of our association fully realize the excellent work done by you on behalf of the so-called minor mechanical organizations, and I am free to confess that without the stimulation of your wonderful magazine the load of caring for the association under the very trying conditions during the past five years would have proved too great and probably would have fallen by the wayside. We have already started our 1936 campaign for new members, working on topics that must be worth while in the eyes of our higher officials and be an incentive to them to send their men to the conventions.

"Pound Foolish" A Masterpiece

In regard to the "Walt Wyre" stories, which I say are not stories but something that is happening every day in the present-day life of a busy roundhouse; I did not think the first two could be improved upon, but "Pound Foolish" is a masterpiece. I often wonder if the "powers that be" realize the cost in time—which is money—that lack of necessary material is responsible for. I could quote a number of instances of serious delays and spoilage of perishables due to lack of foresight coupled with someone trying to cut down his monthly stock balance. How often have I tied up a lathe hand and his machine for a couple of hours machining a five-dollar finished product into something urgently needed, the net result being a great deal of scrap turnings and borings and a finished article that could be bought on the market for a dollar or less. But the power had to be furnished for a fast run. No alibi accepted.

Jim Evans of the S. P. & W.

I was also very much interested in the article ("Pound Foolish") on page 513 of the December, 1935, *Railway Mechanical Engineer,* about Roundhouse Foreman Jim Evans of the S. P. & W., at Plainsville. I think this is one of the most interesting pieces I have ever read in your magazine; I liked it so well that I read it over the second time and have written a letter to our general foreman asking him to request our storehouse officials and others who might be interested, to do likewise.

A Story You Can Tell

It may be thought that our mechanical employees are so far removed from contact with the general public that they can do little, if anything, in improving the public relations of the railroads. This is a great mistake. You are aware of the fact that the charge has been made that the railroads are not progressive, and that they are doing business in the same manner that they conducted it a quarter of a century ago. You and I know that the railroads have made tremendous strides in the matter of improving their service and in reducing the expenses of operation. I think it would be interesting to the average man to know the improvements that have been made in our railroad equipment, which have resulted in reducing the cost of operation and in added security to the movement of passengers and freight. We have effected a tremendous saving in the consumption of fuel, largely due to improved mechanical devices and to the intelligent use of fuel. Not many people know this, and I know of no one better qualified to tell the story than our mechanical department employees. This is just one of many things that the mechanical people have done that has improved our service, and it is a story that those who address public meetings could well tell.

* * *

For explanation see page 88.

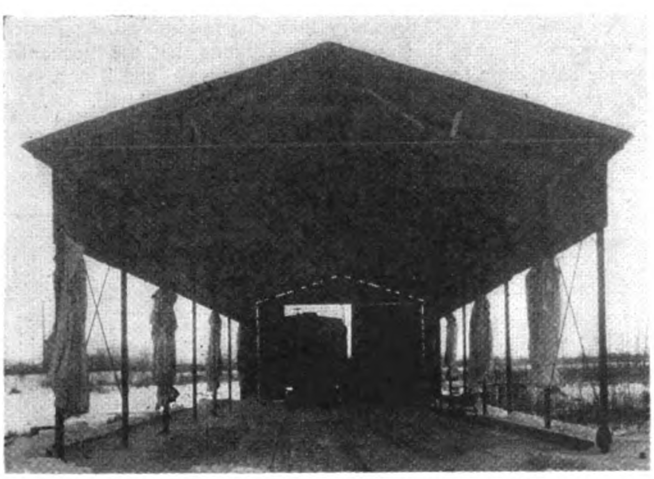
With the
Car Foremen and Inspectors

Port Huron Car Shop Kinks

IMPORTANT improvements in the Grand Trunk Western freight-car repair shops, Port Huron, Mich., include a recently rebuilt shop building, modern crane and other facilities for expediting car repairs, and a shop force organized to handle this work as well as heavy rebuilding operations on an efficient basis. A comprehensive article covering the Port Huron shop improvements and general method of operation will be published in an early issue of *Railway Mechanical Engineer*, the present article being devoted to a description of a few of the numerous car shop kinks and labor-saving devices which have been such an important factor in increasing shop output and reducing unit costs.

Sandblast Shed

One of the features strongly emphasized at Port Huron shops is doing a first-class paint job, especially on steel equipment; and in many instances this requires sandblasting in order to remove all rust and mill scale and get down to the base metal. The sandblast shed has proved an important factor in enabling this work to be done satisfactorily and at minimum cost in all kinds of weather.



New sandblast shed at G. T. W. car shops, Port Huron, Mich.

The shed was constructed as part of the shop improvement program, and is located on a spur track extension northwest of the main shop buildings. The shed is 28 ft. wide by 127 ft. long by 16 ft. high, being constructed in the main of 3-in. by 3½-in. scrap angles, with galvanized iron roof sheets applied over 2-in. by 6-in. purlins and side sheets extending downward only about 5 ft. The supporting posts are spaced on 16-ft. centers and the sides left open during normal operation on fair, quiet days. During inclement weather or on windy days, the No. 8 duck canvas curtains can be pulled out along their supporting wires to cover the open sides of the shed and furnish adequate protection to the sandblast operators as well as increase the effectiveness of their work and prevent the loss of sand out of the building.

The forward end of the sandblast shed is entirely uncovered. The rear end, made of galvanized iron, is provided with an opening large enough to permit entrance of the sand-storage car shown in outline in the illustration. The usual white, dry, silica sand is used, being dumped into the hopper of a sandblast machine in the rear of the shed. From this machine the sand is delivered under shop line air pressure through special Goodrich sandblast hose and suitable nozzles to the car sides or to the parts which are to be cleaned. The sandblast hose is designed for this particular service, being made of special rubber 1⅞ in. in outside diameter and ⅞ in. in inside diameter, and having a very satisfactory service life. The nozzle, known as the Borium S-B type, has an outside diameter of 1⅛ in., inside diameter ½ in. and length 2¾ in., being guaranteed for 300 hours' service life, and frequently lasting as much as 600 hours.

New sand, delivered under an air pressure of 110 lb., is used in removing the enamel finishes from passenger cars, and older sand at 90 to 100 lb. pressure is usually

Double unit paint barrel storage racks at the Port Huron shops

adequate for removing rust and mill scale from freight equipment. All sand is used over again to a maximum of about five times before its cutting qualities are lost. Re-used sand sometimes picks up a certain amount of moisture from the atmosphere and the shed floor and has to be strained and dried in a special drier provided in the rear of the sandblast shed.

Storing Paint Barrels

For a number of years the Port Huron shops have been provided with a modern fireproof paint-storage house with unusually good facilities for handling paint materials and delivering them to the passenger and freight car paint shop forces, as required. An accurate check of the quantities of paint used is obtained and considerable economy has been effected in arranging to have all paint brushes, spray painting equipment, etc., turned in to the paint house for proper care and attention at the close of each day's work.

A feature of the paint house is the provision of substantial steel paint-barrel storage racks and a lift truck, as shown in one of the illustrations. The paint house is equipped with a total of four of these double-unit, four-tier racks, each of which has a capacity to hold 40 barrels of paint. A large increase in paint storage capacity is thus secured without taking up additional floor space.

The double-unit storage racks are 7 ft. wide, 9 ft. deep, 9 ft. high at the front and 8 ft. 10 in. high at the back, to provide a slight incline which will prevent barrels from rolling out of the rack. As an extra precaution, however, two metal stops are inserted under each of the outer barrels, being provided with projecting lugs on the bottom to fit suitable holes in the supporting angle irons. The storage racks are made of scrap 3½-in. angles, keyed

Equipment used in stenciling a car by the spray method

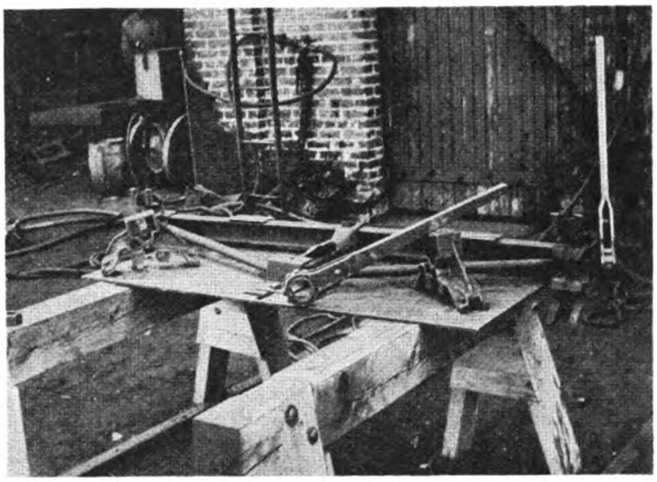
and riveted together, as illustrated. The vertical supports are set in the concrete floor and the entire frame work is rigidly secured to the back wall of the paint house. The horizontal parallel supporting angles are locked in place without rivets by a construction also shown in the illustration. Diagonal tie rods, made of ⅝-in. steel, are installed, as shown, and serve to stiffen the frame work and hold it in position under the heavy loads sometimes imposed on it.

The Barrett portable elevating truck, illustrated, furnishes a convenient means for placing barrels in or removing them from the storage racks. This truck has a total lift of 12 ft. and can be operated either by hand or air motor. A friction lowering device makes it easy to lower barrels from any tier-level to the floor.

Spray Stenciling

A number of railroads are using the spray method of stenciling successfully, but others have not secured the desired results. The principal requirements for success are the use of reliable paint-spray equipment with an air pressure suited to the paint material being used and a stencil which is sufficiently flexible to be fitted snugly against the sheet.

The way this operation is performed at the Port Huron shops is shown in one of the illustrations. The particular spray gun illustrated is the Thor, model No. 6, furnished by the Binks Manufacturing Company, Chicago. The regulator, furnished by the DeVilbiss Company, Toledo, Ohio, is used to reduce the shop-line air pressure from 95 lb. to 35 lb. at the spray gun when a



Special jig used in renewing worn brake-beam heads

heavy stencil paste is used. For lighter materials, the pressure is reduced still more. The type of stencil is clearly shown in the illustration.

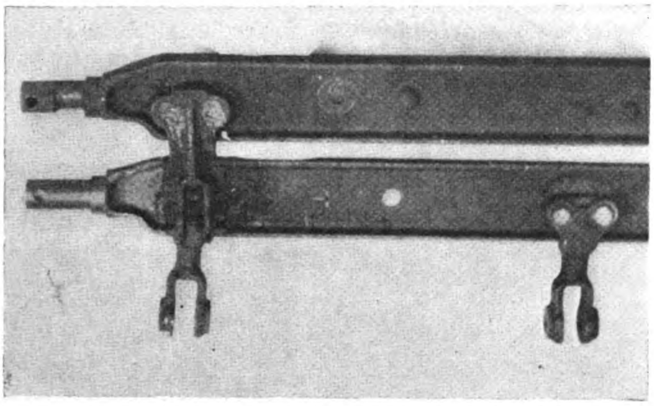
The advantages of spray stenciling, as developed by experience on the Grand Trunk Western and other roads, include neater lettering than was formerly secured, less paint material required, greater speed in stenciling, less frequent cleaning of stencil backs required, and longer stencil life.

Brake Beam Repairs

A.A.R.-Type brake beams with worn heads, but having tension and compression members in good condition, are repaired at the Port Huron shops by means of the special jig and ratchet wrench shown in the illustration. The nut is removed from one end of the brake beam only, using the ratchet wrench illustrated and as much leverage as may be required to turn off the nut. The channel is held in two stationary angle clamps on the jig and the strut end in a movable clamp which can be adjusted to suit brake beams of different style or size. The worn brake heads are removed and new heads applied over the tension rod, the brake beam being re-assembled and a new nut applied and tightened until the required tension is secured. The end of the rod is then headed over, in accordance with recommended practice. Slightly worn brake heads are mated and reapplied for use on certain classes of G. T. W. cars, new heads being used on all system cars.

The method of reclaiming Simplex brake beams with

worn ends consists of reforging each defective end, after welding in a piece of steel large enough to make up for all wear. The ends are drawn out to 1½ in. in diameter and then upset in a forging machine to $\frac{1}{16}$ in. oversize. The brake beam ends are recentered and turned in an engine lathe to the original diameter and length, after which new cotter pin holes are drilled. This gives a brake beam practically as good as new, and the fact that the ends have been turned on lathe centers assures that they will be in line, an important requirement not always met where the attempt is made to forge

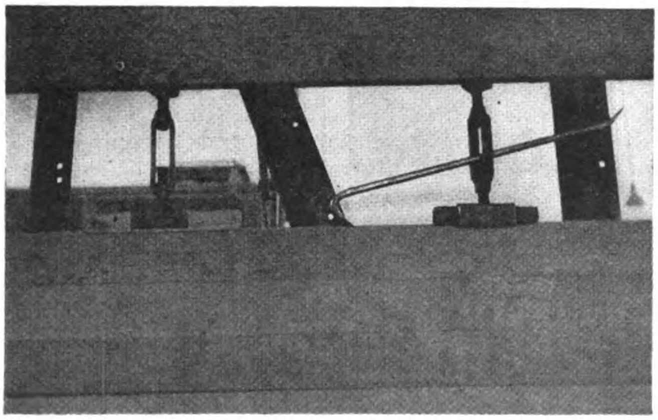


Simplex brake-beam end before and after being reconditioned

the ends directly to finish size. Obviously, unless the brake beam ends are in line and accurately fitted to the heads, uneven and excessive wear of brake shoes and heads will result.

Applying Siding-Draft Gears

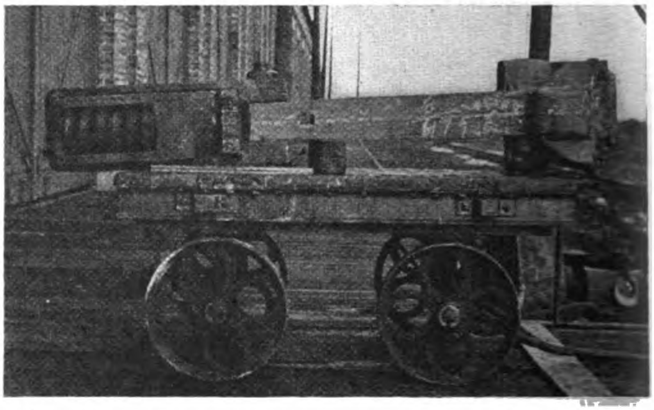
The simple use of turnbuckle jacks in applying new side planks to steel frame box cars is shown in one of the illustrations. The upper turnbuckle screw, or swivel, in each case carries a small metal square which bears



Use of turnbuckles in applying new side planks to a car

against the grooved edge of the upper plank. The lower turnbuckle screw in each case is welded or riveted to a U-shaped piece of sheet metal which carries a hardwood block, grooved to fit over the tongue of the lower plank. After all side planks are applied except two or possibly three, as shown, and due precautions are taken to prevent the planks from springing out away from the frame, operation of the turnbuckles by means of a small hand bar compresses the planks the required amount so that the joints will not open up due to shrinkage when the car is placed in service. When the desired compression is secured, the bolt holes are bored from the inside and the bolts applied. The remaining side planks are driven home, drilled and bolted, thus completing the job.

A four-wheel elevating platform truck, useful for many kinds of work about a car shop, is illustrated. It is used primarily for transporting storage batteries between cars

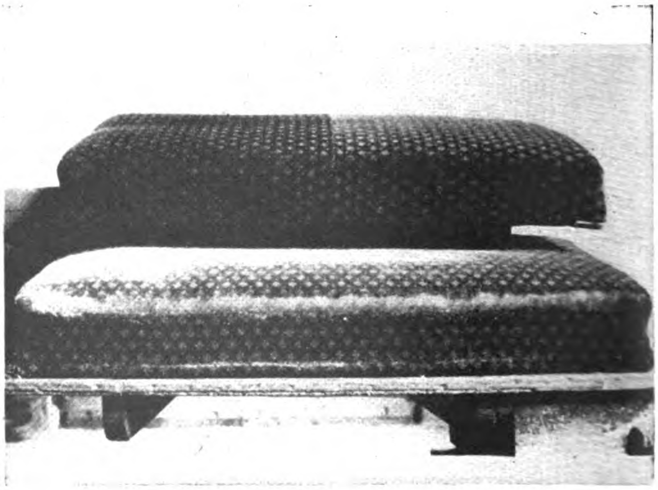


Elevating platform truck used in applying couplers

and the battery shop and also for transporting couplers and draft gears and raising them into position under the car. The platform, normally supported on the truck frame, is capable of being raised by means of four small screw jacks bolted to the frame, one at each corner, and arranged to be operated by a single handle at the front of the truck through suitable bevel gears and a short extension shaft. The lift of the platform is arranged to suit the usual elevation of passenger car battery boxes as well as that of work benches in the battery shop. In removing and reapplying couplers and draft gears, this truck is not only a labor-saving device but an important safety feature, as it avoids the necessity of dangerous blocking. For best results, the wheels of the truck should have roller bearings and the elevating screws be well lubricated, thus assuring easy operation.

Reconditioning Seat Cushions

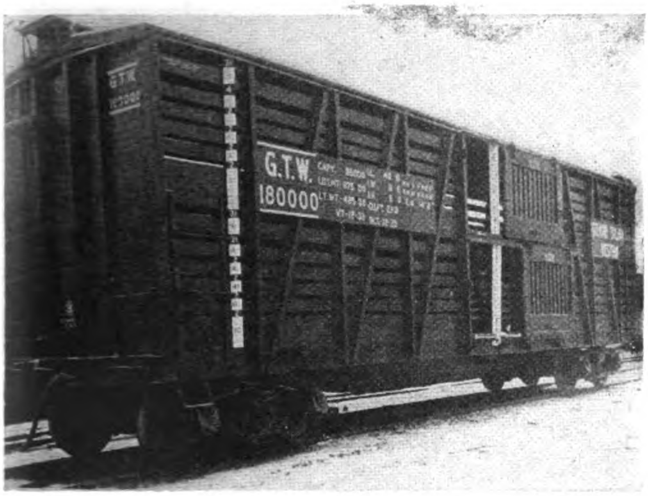
One of the illustrations shows a satisfactory method of reconditioning passenger car seat cushions which have



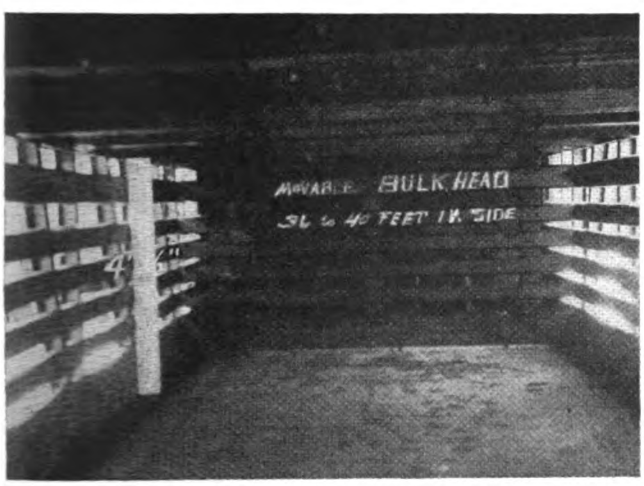
Passenger-seat cushion before and after being reconditioned

become badly worn on account of passengers resting their feet on the edges. The pile is completely worn off the plush at the front edge of the cushion, as shown,

and no amount of cleaning or renovating would make the plush suitable for reapplication to the cushion as it was put on in the first place. The plush is removed from such cushions, thoroughly cleaned, worn parts cut off, and joined by sewing to a similar piece of plush from another seat cushion. The sewed piece of plush is then applied to a reconditioned cushion with the seam



Double-deck stock car rebuilt at Port Huron shops



Interior lower deck view of the stock car showing movable bulkhead for converting from 40-ft. to 36-ft. compartment

at the middle of the cushion, as shown in the upper part of the illustration. It requires the plush from two old cushions to form the renovated covering for one cushion, as described.

Converted Stock Car

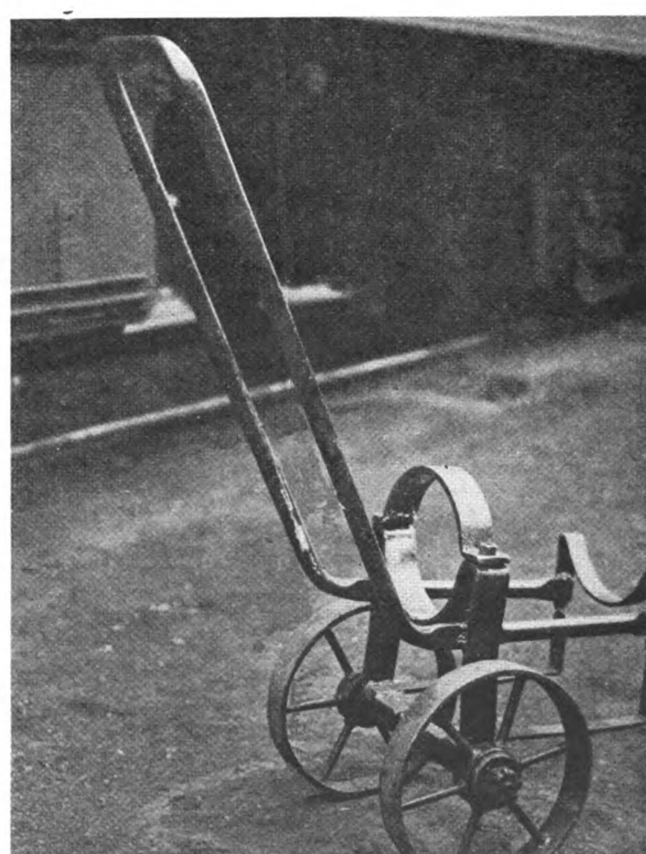
One of the illustrations shows a G. T. W. double-deck stock car which is one of 50 recently converted at Port Huron shops from an old type of automobile box car. The new stock car has a nominal capacity of 85,000 lb., load limit of 87,500 lb. and light-weight of 48,500 lb. The car is 40 ft. long and has a total inside height of 9 ft. An interesting feature is the provision of a vertical strip of wood near one end of the car, painted with alternate white rectangles corresponding to the side board widths and red rectangles corresponding to the spaces between boards. This gage gives a check of proper board spacing and also shows a free height of 49 in. in each deck.

Another interesting detail in the design of this car is the provision of a movable partition at one end of each deck, by means of which a shipper who asks for a 36-ft. car can be provided with compartments of exactly that length and not be compelled to load and pay for a longer car than actually needed. These movable partitions are suspended from double tracks and positioned by means of three 1¼-in. bolts, illustrated, which fit into suitable metal sockets set in the car decks.

Outfit for Handling Freon Containers

ON passenger cars that are equipped with the Freon system of air conditioning it is sometimes necessary to replenish the supply of freon. The loss of freon is generally due either to leaks in the copper tubing or to broken tubes resulting from vibration or due to being struck by objects in terminals. Freon is furnished in containers, smaller, but of similar appearance to the conventional oxygen cylinders. The handling of these cylinders in the terminal coach yard or at passenger stations can be simplified by the use of a two-wheeled wagon such as shown in the illustration.

The handle and frame of the truck is constructed from 1½-in. wrought iron pipe to which is welded pieces of 1¼-in. flat iron straps which serve to secure the container to the cart. The wheels are mounted on a 2-in. axle and are equipped with roller bearings to facilitate the handling of the outfit by one man.



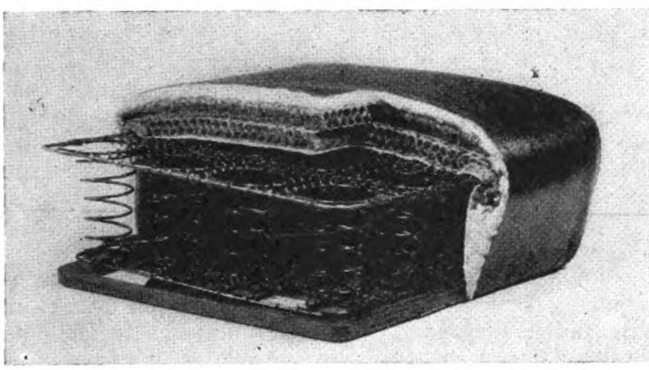
This simple two-wheel truck simplifies the handling of Freon containers

Latex Upholstery Material

A NEW upholstery material, using Latex and a unique method of fabrication, is announced by the B. F. Goodrich Company, Akron, Ohio. Known as Nukraft, this material, it is claimed, offers many advantages as a spring decking in the construction of railway car seats.

It consists of hair cloth, insulated with Latex, which has been fabricated into loops forming a structure of figure eight springs. The resulting material is soft, buoyant, and elastic, yet has sufficient structural strength to bridge the open spaces between the springs, presenting a smooth, comfortable surface through which the springs will not protrude.

Nukraft is applied in two-ply thickness directly over the burlap or canvas covered spring unit, a thin layer



Section of seat cushion showing Latex woven into a figure-eight structure to bridge the springs

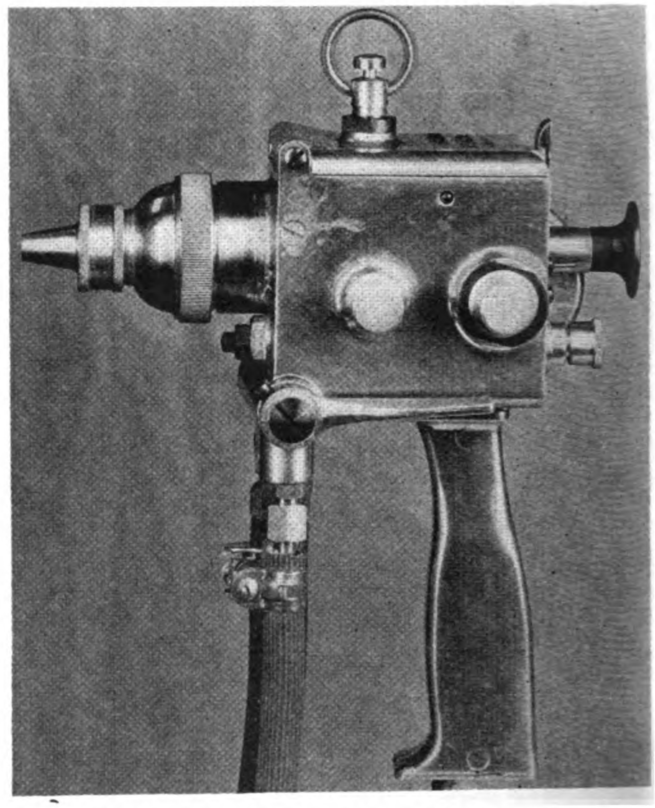
of cotton is placed on top and the cushion is then ready for covering. Nukraft locks the cotton in place and prevents it from shifting and bunching and makes for a permanently smooth surface through which the springs cannot be detected. This construction assures the proper ventilation necessary to seating comfort because of its fabrication in loops which permits a continuous air circulation regardless of the amount of pressure applied.

Metal Spray Unit

A NEW metal spray unit, known as the "Mogul," has recently been developed by the Metallizing Company of America, Los Angeles, Cal., and is being distributed by the Metallizing Engineering Company, Inc., with offices in New York and Chicago. This new unit, made by the same company which produced the original "Metallizer gun," incorporates certain improved features rendering the new design adaptable to unusually severe operating conditions in metal spraying service.

Primarily, the metal spray gun is intended for mounting in the tool post of a lathe to be used for machine element coating and for that reason no particular effort has been made in the design to keep the weight at a minimum. Nevertheless, it is not too heavy to be used as a portable tool and will be available for that purpose as well as a lathe tool.

One feature worthy of note is that the wire-feed mechanism and gas head, while attached to each other, are, in reality, separate units. This departure from the usual design reduces the replacement cost in case either assembly is damaged, and, furthermore, permits a better combination of metals being used for the construction of these parts. Moreover, the complete separation of the gas head and wire-feed mechanism is an insurance against combustible gas mixtures working back into the



"Mogul" metal spray unit designed for severe service conditions

enclosed gear case through gas-mixing channels drilled in the gear case proper.

The wire-feed unit is self-contained, and all the worms and gear-shafts are mounted on annular ball bearings. These assemblies run in a bath of fluid grease and are completely enclosed in a dust-proof case. The use of annular bearings insures permanent alinement of the worms and gears and reduces wear on these parts to a minimum. The turbine has surplus power and runs at a slower speed than is ordinarily found in equipment of this type, thus maintaining a steady flow of power without continual adjustment.

The various parts of this unit, designed with a full appreciation of the service to which they will be subjected, are made of carefully selected materials. The gas head is a bronze casting, and the simultaneous control valve is of hard bronze. Excellent wearing qualities are assured through the use of this combination of materials and the valve is designed to need little attention. The gas and oxygen mixing is done in a metering tube so constructed that there is little likelihood of flash back down the oxygen hose. A hardened steel wire guide tube is incorporated in the assembly so as to reduce wire wear in the parts of the front end.

The thought behind the "Mogul" has been to produce a metal-spray unit which would stand up under severe service. The new gun does not replace the "Metallizer gun" but is a high-power, hard-built production tool, Model A being available for the production spraying of

steels, monel and nickle, and Model B for spraying aluminum, bronzes, copper and brass.

In the railway field, as well as in general industry, the "Mogul" metal spray gun is used largely as a maintenance tool, providing an economical method for restoring worn armature shafts, rods, and other similar parts to their original size. In addition, non-corrosive coatings can be applied as needed. The process has been used successfully for building up innumerable worn locomotive parts, such as pins, bushings, links and link bars, air brake valve parts, piston rods and throttles, feedwater pump rods and castings. One of the important potential uses of the metal spray gun is in the application of protective coatings, as mentioned. For example it has been used for applying a zinc coating to passenger car platforms, steps, window jams, sills, the lower part of toilet room walls and dining car kitchens. Battery boxes have been coated with lead and the insides of tank cars and water tenders with zinc. Considerable success has also been attained in coating with zinc the water side of fireboxes and boiler tubes as a protection against pitting.

Paint Cleaner And Protector

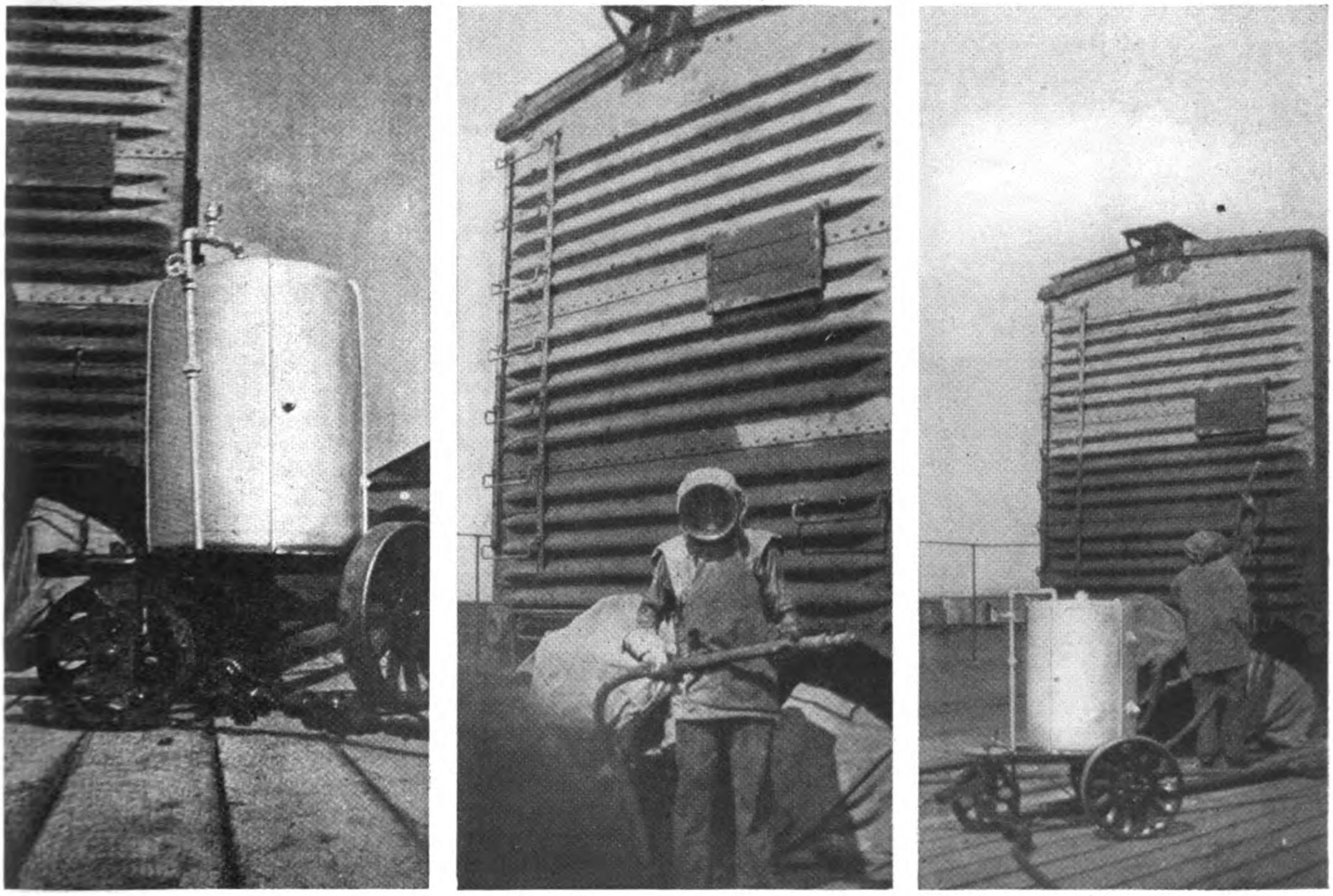
A NEW method of restoring old paint on passenger and freight cars and then protecting the surface so as to extend its life has been developed by the Gregg Company, 1418 Walnut St., Philadelphia, Pa.

On equipment which has been in service for some time and on which the painted surface has acquired a coating of grime and dirt, the paint is first washed with clear water, using a hose, and then brush scrubbed with a solution of "Drion" car cleaner. This loosens and dissolves the coating of dirt without injury to the paint itself. After a section has been cleaned it is again washed off with clear water, applied by a hose. The surface is then coated with Drion triple-life finishing solution, applied, if desired, by a cotton mop dipped in the solution. Even better results are claimed by spraying on the finishing protective coating. This finish is said to dry quickly, leaving a colorless, air-tight and hard, yet flexible, coating which retains its elasticity for an extended period of time. After this coating has been applied the surface can usually be cleaned by a dry mop only.

On newly painted equipment, after the surface is dry, the application of a coating of Drion triple-life finish is recommended before the car is placed in service.

Portable Sand Blast Machine

THE illustration shows a portable sandblast machine which is being used at the Great Northern car shops, St. Cloud, Minn., for sandblasting steel ends and steel underframes on freight cars requiring general repairs. The tank, 21 in. by 26 in., and tested to 150 lb. pressure, is mounted on a three-wheel carriage. The vital mechanism of this machine is the mixing chamber, made of a section of 3-in. pipe, 56 in. long and reduced at each end to 1 in. by welded plugs into the pipe. The



Portable sandblast machine and equipment, including glass-faced operator's hood, used at St. Cloud shops of the Great Northern

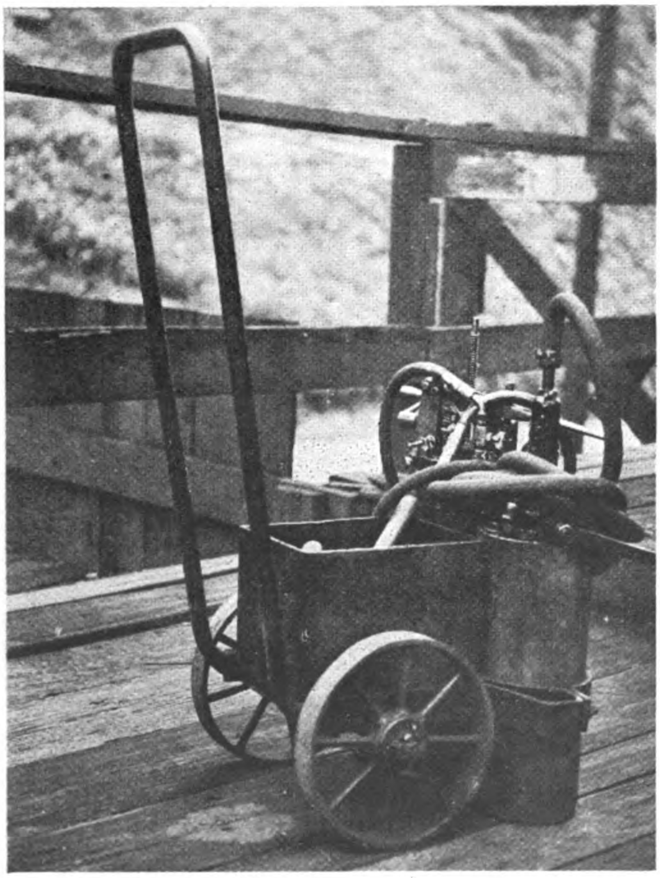
air pressure enters the chamber at the left end, as shown in the illustrations. A ½-in. air pipe also leads into the top of the tank, and a small ½-in. valve is placed in the ½-in. pipe to regulate the air. A 2-in. connection is welded into the top of the tank for filling. A 1¼ in. cut-out valve connects the bottom of the tank with the mixing chamber. By the use of this valve, the amount of sand delivered is regulated. A heavy-duty hose is attached to the other end (right end of chamber). A cast iron plug is fitted into the end of the hose, and a 7/16-in. hole drilled through this plug. If desired, the hole can be threaded and a short nipple screwed into it. However, the use of a hose with the plug provides a flexible end which is generally preferable.

The illustrations show a 50-ft. automobile car with steel end partially blasted. The dimensions of the car end are approximately 10 ft. high by 9 ft. 6 in. wide, the average time consumed for sand-blasting with this machine being 20 minutes.

One of the illustrations shows the hood worn by the operator of this sandblast machine, the unique feature of this hood being that the glass dial of approximately 7 in. or 8 in. diameter which is fastened into a steel ring and can be easily removed when it gets pitted.

Portable Lubrication Cart

THE lubrication outfit shown in the illustration is used by passenger terminal maintenance forces in connection with the lubrication and daily adjustment of air conditioning equipment.



Cart for air-conditioning maintainers holds lubricants and tools

Heavy lubricant is provided in one of the two containers for use in gear boxes while the other container is filled with grease suitable for application to fittings on generator, pump and compressor bearings. In addition to the two lubrication containers the cart is provided with a receptacle of sufficient capacity to carry the various wrenches and other tools that may be needed in connection with the maintenance of air conditioning equipment.

The cart is mounted on two 18-in. wheels equipped with roller bearings. The tool container is made from ¼-in. copper-bearing steel sheets which may either be riveted or welded together. The handle is made from 1¼-in. wrought iron pipe.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Repairs Claimed Excessive And Unwarranted

Five G. M. & N. cars and 3 N. O. G. N. cars were repaired by the New Orleans Public Belt Railroad and charges included in regular monthly bills. The Gulf, Mobile & Northern took exceptions to charges, claiming extensive repairs had been made in violation of Rule 1, paragraph (b). The N. O. P. B. claimed repairs made were the minimum necessary for safety of lading and trainmen. Case was appealed.

The G. M. & N. claimed that the N. O. P. B. had made unwarranted repairs in violation of Rule 1, paragraph (b). A statement was submitted showing bills for the eight cars totaling $225.69, ranging from $10.13 to $57.28 per car. The N. O. P. B. is a switching road with whom they made connections at New Orleans.

The N. O. P. B., in analyzing bills, stated that none of the cars was subject to disposition under Rule 120. It was contended that a similar case was covered by Arbitration cases 1033 and 1094, and that repairs were within scope of Rule 16 and not in violation of Rule 1, paragraph (b). The majority of G. M. & N. cars were afterwards loaded on their line with various commodities. It was stated that they were compelled to make repairs to foreign cars in order to meet demands for first-class equipment and that it would be bad policy to subject industries to delay caused by lack of suitable equipment. It would be difficult to handle requests for empty cars, preparing only certain cars and making only certain classes of repairs. The N. O. P. B. serves many industries and, in the first ten months of 1931, 26,420 cars were loaded, of which 1,054 were delivered to the G. M. & N. During the period less than 100 G. M. & N. cars were repaired. Foreign cars returned to G. M. & N. under load greatly exceeds G. M. &.N. ownership repaired on their line and returned. Repairs in question included brake beams, decking, side doors, lining and roof boards. Repairs were considered necessary for

safety of lading and trainmen and it was felt they were justified in making them.

In a decision rendered April 11, 1935, the Arbitration Committee said: "The repairs in question do not exceed the minimum necessary for safety of car, lading and trainmen, as provided in Rules 1 and 16. Therefore, claim of the Gulf, Mobile & Northern is not sustained." —*Case No. 1741, Rules 1 and 16, Gulf, Mobile & Northern vs. New Orleans Public Belt Railroad.*

Improper Repairs on Basis of Billing Repair Cards Covering Control Valve

The Chicago, Rock Island and Pacific cleaned the air brakes on S. P. baggage car 6446, February 15, 1932, at Chicago and issued billing repair card showing U-12-B type U. C. control valve removed and applied. The Rock Island again cleaned the brakes on the same car December 9, 1932, and, as shown on billing repair card, a U-12 type U. C. control valve was removed and applied. The Southern Pacific matched the two C. R. I. & P. billing repair cards and forwarded documents to the latter road requesting adjustment of overcharge in amount of $85.00. C. R. I. & P. maintains that subsequent billing repair card cannot be considered valid as joint evidence if car has been on home line during interval between first and subsequent repairs and demanded evidence of wrong repair per Rule 12. The S. P. claimed this was unnecessary, as C. R. I. & P. billing repair cards in themselves constitute joint evidence. Failing to agree the case was appealed.

The Southern Pacific in its statement said that the question at issue is whether or not the two C. R. I. & P. billing repair cards issued in February and December covering air brake work on S. P. car 6446 served as joint evidence of wrong repairs. It was evident that these were conclusive evidence of wrong repairs in December as previous card showed car equipped with U-12-B valve at that time and that in accordance with item 20-C of passenger Rule 21, a credit of $85.00 is due.

The C. R. I. & P. in its statement called attention to care taken by repairs forces at Chicago and maintained that a U-12 valve could not have been substituted for a U-12-B valve in December and that they must refuse responsibility and expense of wrong repairs without the submission of joint evidence by owner in accordance with Rule 12. The car referred to was delivered by C. R. I. & P. to S. P. in interchange service six times between February 17, 1932, and December 11, 1932, and received back from S. P. five times. The car was not on line of C. R. I. & P. between May 8 and December 8 when air brakes were repaired a second time on December 9. It was contended that C. R. I. & P. position was supported by Arbitration Decisions 1381 and 1709.

In a decision rendered April 11, 1935, the Arbitration Committee said, "Car owner failed to obtain joint evidence within 90 days after first receipt of car home as required by Rule 12. The contention of the Southern Pacific is not sustained."—*Case No. 1742, Rules 12 and 90, Southern Pacific vs. Chicago, Rock Island & Pacific.*

Transfer of Lading—Expense of Cleaning Tank Included

E. R. I. X. tank car 610, loaded with fuel oil, was received from the Santa Fe at Ponca City, moved to Kansas City and delivered to Union Pacific, being destined for Omaha. On arrival at U. P. yards at Kansas City an inspector of the Kansas City Car Interchange Bureau reported car in bad order account outlet pipe broken off and cap missing and leaking at outlet valve. Authority was issued to U. P. for cost of transferring load. The U. P. intercepted C. H. I. X. car 8416, previously loaded with kerosene, into which to transfer the fuel oil and agreed to pay the cost of cleaning after car was unloaded, to make it suitable for the same commodity with which it was previously loaded.

The C. R. I. & P. in its statement said that the U. P. in rendering bill on authority of a transfer card included a charge for $18.00, the cost of cleaning C. H. I. X. car 8416 after the fuel oil was unloaded, claiming expense to be a proper charge against delivering line per arbitration decision 1440. C. R. I. & P. contended that U. P. made no diligent effort to locate a suitable car into which to make the transfer, but intercepted the first available car, which happened to be clean, rather than pick out a fuel car from those passing through Kansas City daily in large numbers, and therefore, declined to pay the cost of cleaning. In Case 1440 it was shown that the V. S. & P. endeavored for several days to locate a suitable car and being unable to do so secured a car with the understanding that it would be cleaned afterwards and restored to its original condition. In the present case apparently no effort was made to find a suitable car because the entire transaction of picking up the car and making the transfer consumed only 4 hr. and 15 min. It is, therefore, contended that decision in case 1440 is not parallel and that the cost of cleaning is not a proper charge against the C. R. I. & P.

The Union Pacific in its statement said that E. R. I. X. car 601 was entitled to best movement possible. Immediately after it was found leaking and marked for transfer, a check was made of U. P. yards to locate a tank car of similar capacity which had last contained a commodity that would permit its use without prior or subsequent cleaning. No suitable car being available, arrangements were made to use C. H. I. X. car 8416, with the understanding that this was a clean car in kerosene service and U. P. would accept bill for cleaning when car was released. In rendering its bill the U. P. included $18.00 for cleaning as part of cost of transfer and maintains that procedure was supported by decision in case 1440. E. R. I. X. car 601 was delivered to U. P. by C. R. I. & P. at 12:15 P. M. April 6, 1933 and scheduled to move out of Kansas City over U. P. at 5:00 P. M. the same day. Search for a suitable car required approximately 3 hr. leaving only 2 hr. to effect transfer and switch car into scheduled train. Referring to contention by C. R. I. & P. that the U. P. finding it had no suitable car should have called upon the Rock Island, or some other connecting line for a suitable car, it was stated that the Rock Island could not have furnished a car in time to avoid delay for the reason that the next regular delivery from Rock Island to Union Pacific was scheduled at 11:00 P. M., and also that even if a suitable car had been found, as only 2 hr. remained in which to make a transfer, the C. R. I. & P. could not have furnished a car in time to maintain scheduled movement of load, even if such a car had been found available. In order to avoid delay the U. P. had no other recourse than to use a car that would require cleaning after release.

In a decision rendered April 11, 1935, the Arbitration Committee said: "The position of the Union Pacific is sustained. Decision No. 1440 is parallel." *Case No. 1744, Rule 2, Chicago, Rock Island & Pacific vs. Union Pacific.*

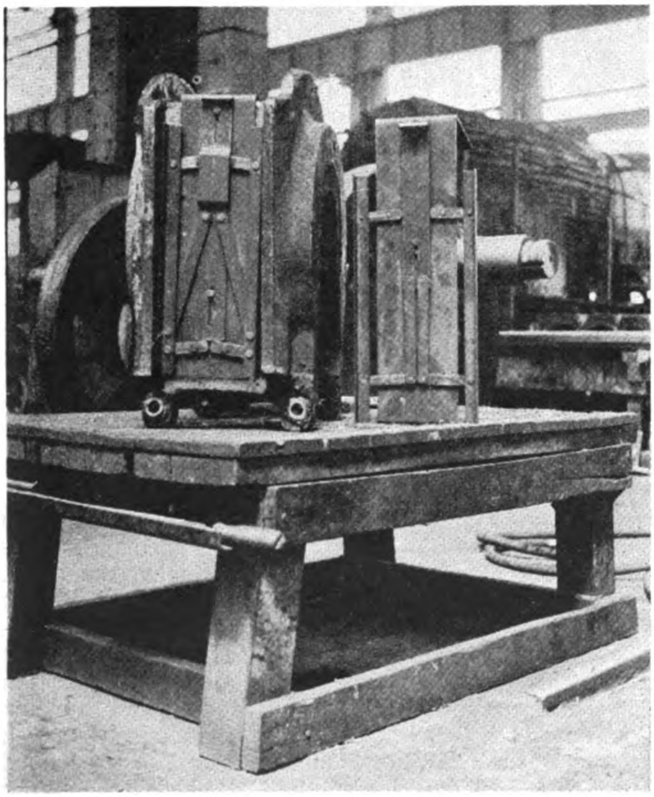
In the
Back Shop and Enginehouse

Labor Saving Devices at Albuquerque Shops

A NUMBER of relatively simple but effective devices for saving labor at the locomotive shops of the Atchison, Topeka & Santa Fe, Albuquerque, N. M., are shown in the illustrations. In general, these devices are neither complicated nor expensive to make, and they are typical of the many ingenious gages, test racks, work-holding fixtures and material-handling devices which railway shop men have developed in recent years to assist them in maintaining production with reduced working time.

Checking Driving-Box Saddle Seats

A special gage for checking the frame clearance of driving-box saddles and making sure that the saddle seats are properly squared is shown in the illustration.



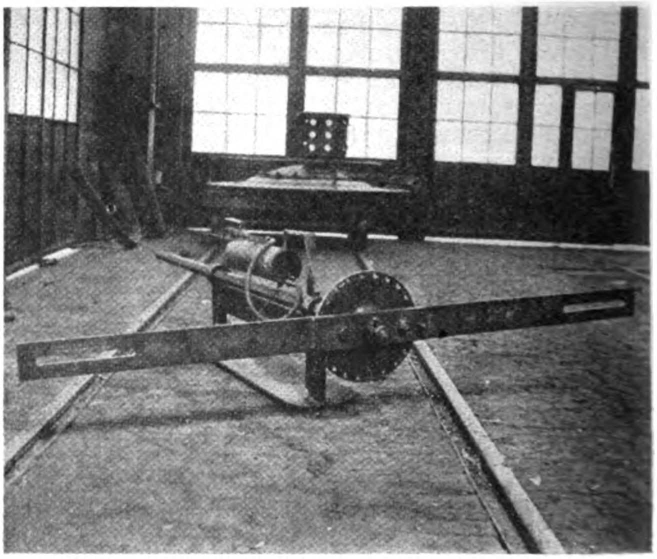
Special gage for checking driving-box saddle seats

This gage consists of two steel plates, one of which extends over the top of the box through the saddle and shows the exact center line of the shoe-and-wedge faces. The other plate fits in the shoe-and-wedge face of the box, being automatically centered by two short pieces of angle steel capable of parallel extension against the sides of the shoe-and-wedge ways. The construction of this gage is quite clearly shown in the illustration.

In using this gage, the saddle is placed on the driving box and the gage is applied between the flanges and against one of the shoe-and-wedge faces. The parallel angles are then pressed out until they contact the flanges. The saddle clearance can at once be noted by measuring from the center line. Squareness of the saddle seats on the box is checked by using a combination square from the top plate to the saddle seat.

Drilling Holes in New Cylinder Saddles

The process of changing from cast-iron to cast-steel cylinders on certain classes of Santa Fe power developed the need for a more efficient method of drilling cylinder saddle-bolt holes, formerly done by using a portable pneumatic drill and an "Old-Man" which had to be changed in position for each hole. The device illustrated has been developed to give proper radial alignment to the motor and permit the drilling of all holes with one set-up.



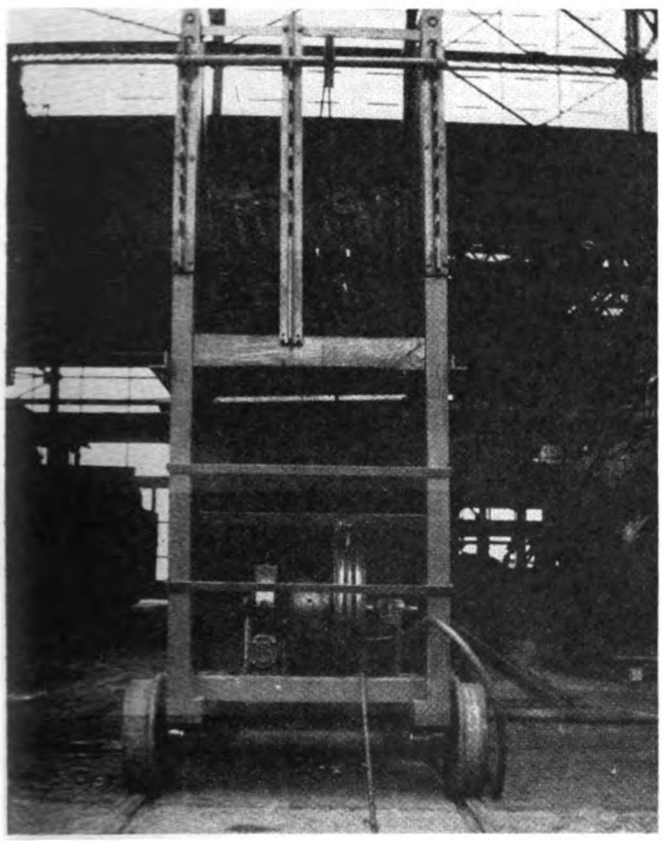
An unusually convenient cylinder-saddle drill jig

The drill jib is T-shaped and consists of a hexagon bar with indexed crosspiece of flat steel. The crosspiece is bolted to the front-end door ring, on the smoke box center line and the end of the hexagon bar is placed in the center flue. A sliding saddle moves on the bar, the lower section of cylindrical plate serving as a stop for the air-motor feed screw. On top of the saddle is placed a small sheet metal cylinder to contain the cutting compound which is allowed to flow by gravity through a small hose line to the point of drill. The circular plate at the junction of the bar and the crosspiece is indexed, as shown, to permit locking the bar in place when drilling holes at an angle. This drill jig, which is set up and operated by one man, is said to reduce the time of drilling cylinder saddle-bolt holes 50 per cent.

Device for Removing Superheater Units

With the application of Type E superheater units, difficulty is sometimes experienced in removing these units when repairs are necessary to the units, flues or flue sheets, since each of the four loops of each unit is in a separate flue and there is a tendency to jam or bind when the units are being removed. To meet this condition, the superheater unit puller, was developed.

The device comprises a ladder-type scaffold and platform, carried on four flanged wheels and having a power unit in the base which consists of a track-wrench motor of a type now obsolete for its original purpose. This motor operates from the shop air line and drives a Foote reduction gear with a ratio of 11½ to 1. A shaft, mounted on the base of the scaffold back of the motor and not shown in the illustration, carries two drums for winding up the rope used in pulling units. The single sliding pulley and shaft at the top of the scaffold are capable of vertical adjustment as required to give a direct pull on the units. A platform provides firm footing, at the proper elevation, for men engaged in removing the units. A unit-carrying platform, mounted on wheels, is placed between the puller and the locomotive front end.



The superheater unit puller, set in place ready for operation

In operation, the unit puller is blocked the proper distance away from the locomotive front end and a chain placed on three units at once, the puller rope being given a turn or two around the large drum and the air motor started. In most cases this pulls the three units immediately. However, if any difficulty is experienced, the rope is applied around the smaller drum, which decreases the speed and greatly increases the pulling power. The use of this device has reduced the time of unit removal about 75 per cent. Two men only are required, one operating the motor and the rope connection and the other hooking on units and properly positioning them on the unit-carrying platform.

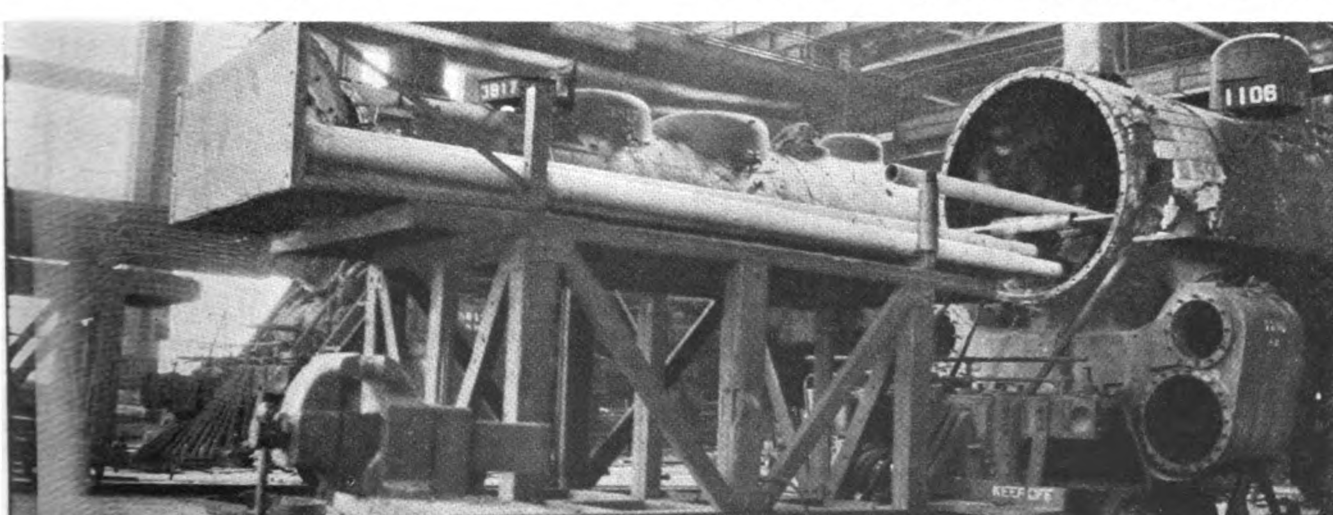
Quick Removal of Flues from Boilers

Recent substantially increased flue work at Albuquerque shop has been greatly expedited, at least insofar as handling flues is concerned, by means of the ball-bearing roller shown in one of the illustrations. This device consists of a cylinder made of steel tubing which operates on ball bearings around a shaft of smaller size. Provision is made for shortening or lengthening the bars to fit smokeboxes of different size by means of a telescoping tube construction, with small pins used to hold the telescope sections wherever they may be set. The ball bearings used are old bearings removed from centrifugal feed-water pumps.

The general idea of this device is to provide a free running support for boiler tubes and flues as they are being removed from locomotive front ends. Three men were formerly required for this work, but the use of the ball-bearing roller permits the tubes and flues to readily slide out against the sheet-metal stop on the flue rack and save the work of at least one man.

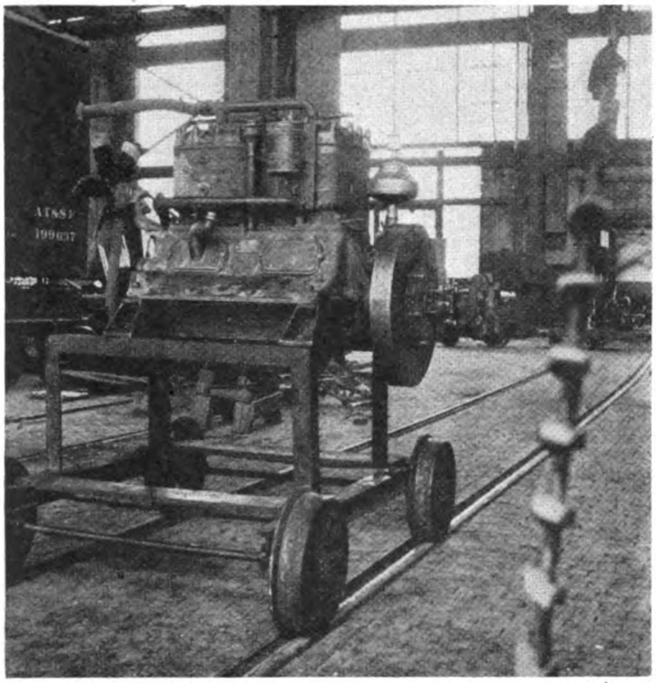
Portable Rack for Repairing Gasoline Engines

To facilitate repairs on large gasoline engines for work equipment, a portable rack has been developed, as



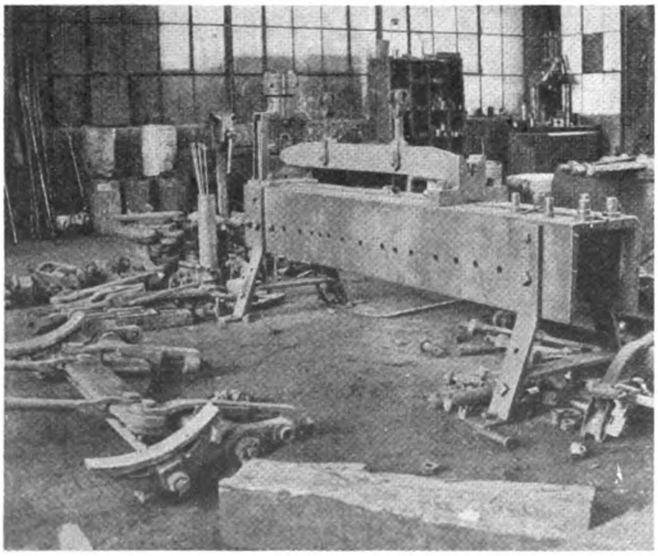
Ball bearing cylinder which facilitates removing tubes and flues from locomotive front end

illustrated. This consists of two pairs of old push-car wheels carrying a welded frame built up of steel bars and angles and arranged to support the engine at a suitable height for most convenient work. The upper parts of the engine can be readily reached by standing on the lower bars of the frame, and ample room is provided to get under the engine for necessary inspection and repairs.



Portable gasoline engine repair and test rack

This portable rack provides a convenient means of moving the engine on standard-gage rails between the various shop departments, and it also serves as a test rack to support the engine during preliminary break-in operation. The rack, which is easily made, has demonstrated its value in the reduced time of handling work-equipment gasoline engines during necessary repair and testing operations.



Special swedging device used in finishing welded tender brake-beam ends without subsequent machining

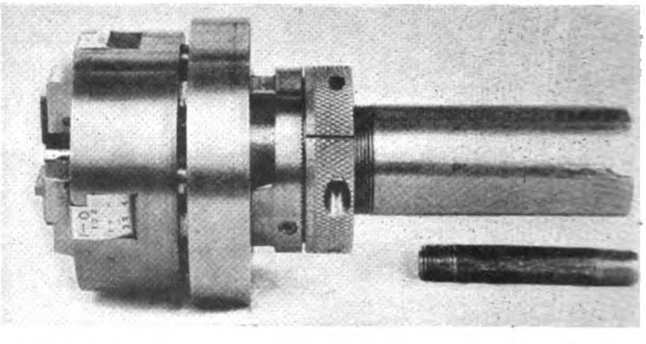
Building up Worn Tender Brake-Beam Ends

To eliminate the necessity of turning tender brake-beam ends, after being built up by autogenous welding, the device illustrated has been developed and is now giving satisfactory service at Albuquerque shops. It consists of a long rack equipped with an adjustable sliding block to support one end of the brake beam and dies at the other end, operated by an old flue swedger. After the building-up operation is completed and while the brake beam end is still hot, it is placed in the die and swedged down to a smooth finish of proper size to fit the hole in the brake-shoe head without further machining or finishing. The machine set-up time and the time and cost of the machinery operation, itself, are thus saved.

Taper Chaser Die Heads

An IMPROVED line of chaser die heads has been developed by the Eastern Machine Screw Corporation, New Haven, Conn., for cutting taper pipe threads. The die head is designed to cause the chasers to recede at a definite rate until, when the proper length of thread is cut, the die head instantly opens, withdrawing the chasers from the work. The actual taper is governed by the action of the die head instead of being dependent on the chasers themselves and thus pipe threads with proper taper are assured.

The chasers do their cutting at the chamfer only, leaving no visible marks. Taper action is obtained by means of a rotating opening cam placed between the back plate of the head and the knurled adjusting nut on the shank. The angular position of this cam is determined by a work plunger inside of the die head shank, which, when pushed back by the work, rotates the opening cam at a pre-determined rate. This rotating cam is adjustable for position and together with adjustment of the work plunger, determines the length of taper thread. The amount of taper is fixed by the incline on this opening cam and the final opening of the die head is accomplished by a sudden drop in the cam. A fine adjustment for pitch diameter is obtained by the knurled adjustment nut.



H. & G. taper cutting inserted chaser die head, style TM

These die heads may also be equipped with a chamfering and reaming tool that will chamfer and ream the end of pipe nipples at the same time that the thread is being cut.

Jim dressed slowly, still about half asleep

FROM SEVEN TO SEVEN

***by* Walt Wyre**

JIM EVANS was snoring like an oversensitive boiler pop and almost as loud, when the alarm clock on a stand by his bedside rattled insistently. Jim stirred uneasily, reached over and shut off the alarm without waking, and murmured, "That blamed switch engine bell is cracked," and was almost instantly snoring again.

He didn't snore long; his wife poked him in the ribs. "What are you grumbling about?"

"Huh—huh—" Jim grunted.

"Wake up, five-thirty," Mrs. Evans reminded him.

He yawned prodigiously, and with an effort opened one eye. He was thinking about trying to open the other when his wife gave him another dig in the ribs, and the eye opened involuntarily.

"Get up!" Mrs. Evans insisted.

"Dadblast it! I was dreaming—dreamed that roundhouse foremen didn't have to work but eight hours a day and had every other Sunday off when that blamed switch engine came by and—"

"Well, being as it was a dream and you are supposed to be at work by seven o'clock, you'd better drag out!"

Jim drug out. After a little fumbling, he found the light switch and turned on the light. His wife followed close behind, wriggled into a heavy bath-robe, fur trimmed house slippers, and shuffled towards the kitchen. Jim dressed slowly, still about half asleep, and was splashing his face with cold water to wake it up when the sound of toast being scraped reminded him breakfast was just about ready.

He finished breakfast, smoked a cigarette with his second cup of coffee, and was ready to go. When he opened the door, a blast of icy air struck his face; frost crystals sparkled in the beam of a flashlight he played on the ground before him as he walked to the garage.

The starter on the car did its best when Jim pressed the switch, but its best wasn't enough. Congealed oil held bearings and glued pistons to cylinder walls with a tenacity that the starter couldn't overcome. He found the crank and bent the handle turning the cold motor. A couple of "p-futs" rewarded ten minutes of effort and profanity.

"Want me to help you?" Mrs. Evans called from the doorway.

"Hell, no! I'll walk," Jim replied, and started on the mile walk to the roundhouse.

A tinge of red was showing in the east when Jim reached the roundhouse. It wasn't yet light enough to see well, but he didn't need light. Eight of his twenty-odd years with the S. P. & W. had been spent as roundhouse foreman at Plainville.

THE seven o'clock whistle blew just as Evans reached the roundhouse office. Bob Parker, the night fore-

man, muffled to the ears in sheep skin coat and fur cap was waiting to go home.

"How's things going?" Jim greeted.

"Oh, about so-so," Parker replied. "Pretty cold; had trouble with the fuel oil, so cold the pump wouldn't handle it. Dynamo froze and bursted on the 5088. S'all in the dope book," Parker told him. "But it's not near as cold as I have seen it. Why, I remember one time when I was on the Big Four—"

"Anything called?" Jim interrupted.

"5092 for No. 11. The passenger is three hours late; be in about eight-ten; engine's outside," the night foreman replied as he opened the door to leave.

Evans took a chew of "horseshoe" and sat down at his desk to look over the dope book and the morning line-up. On account of the cold and high winds, trains were running late in spite of reduced tonnage and extra sections when necessary. The way the line-up showed it, there would be one extra engine over the number required, counting the 5076 that would come in No. 11.

"Well, that's not so bad," he mused as he gathered up work reports and slips. "Hope the 5076 don't have too much on her."

The phone rang before Jim finished sorting the work slips. The night clerk went off at six A. M. and the day clerk didn't come on until eight. Jim answered the phone. It was the dispatcher wanting to know what engine for the Gold Ball east bound freight No. 82. Jim told him and went back to sorting work slips. Starkey, the general foreman, came in just about time Evans was through.

After exchanging greetings with the general foreman, Jim went to the roundhouse. He distributed the work slips in pigeon holes for the various mechanics. Almost subconsciously he gave each man of a craft the particular class of work the man could do best. The slips were distributed and work reports placed in holders in front of the engines to be worked by the time the eight o'clock whistle notified the day force it was time to go to work. It took about fifteen minutes to get the bunch lined out.

Jim was circling the turntable pit on the way back to the office when he met the engineer that was to go out on No. 11. "Branch pipe froze solid," the hog-head told him.

Evans swore fervently, mentioning the ancestry of hostlers in general, and the one on the third trick in particular that had allowed the branch pipe to freeze. He took a fresh chew and went back to the roundhouse to look for a pipe man.

While he was looking for the pipe man, Machinist Johnson stopped Evans. "We've got the dome cover off the 2874; wish you'd take a look at the throttle valve."

"Be back in a minute," the foreman said without stopping.

There was a thirty-minute delay on No. 11 thawing the frozen pipe. After it was thawed, Jim went by the 2874 to look at the throttle.

"Say, Mr. Evans, we need some blacksmith coal," the blacksmith told the foreman as he came down off the 2874. "And some one on nights used the fire last night—heated brass or something—anyway, I had to clean it all out before I could make a weld," he complained.

"O. K., I'll tell the storekeeper to order some coal and leave a note to Parker about night men using the forge. They have orders to use the gas furnace for heating," Evans added.

IT took Jim fifteen minutes to get to the roundhouse. He was stopped four times on the way. He had just sat down at the desk, feet propped on an open drawer for a moment's relaxation, when the inspector came in.

"There's a bad crack in the left cylinder casting of the 5076; she came in on No. 11." The inspector beamed, as though finding a cracked cylinder on the only extra engine that was available for service at the time was something to be proud of.

Evans' feet dropped to the floor with a thump. The inspector followed him out to the 5076. The casting was cracked. No doubt about it, right up next to the flange where the two cylinder castings bolted together. A thin white line showed where steam had been leaking.

"Well, we can't run it that way, that's a damned cinch!" Jim remarked reflectively. "Maybe we won't need her," he added hopefully.

He went back to the office to break the news to the general foreman.

"How long will it take to get the 5082 off the drop-pit?" Starkey asked.

"Oh, hell—two days at best without working over-time on it, and I'd rather pay it myself than listen to the master mechanic rave about overtime."

"Yeah," Starkey said, "but they're standing on his tail about it too. Maybe we can make out somehow."

The phone interrupted the conversation. "Roundhouse clerk talking." John Harris picked up a pencil as he answered the phone. He made notes on a pad of yellow clip as he listened. "O. K., I'll tell him." Harris hung the receiver on the hook. . . ."Dispatcher wants an extra east at eight o'clock—trainload of movie people from Los Angeles—said to be sure and have a 5000 in good shape. Conover is riding the train," Harris added. Conover was the superintendent of motive power.

"Now ain't that nice?" Evans' voice dripped sarcasm. "Where'm I supposed to get any 5000 engine, let alone a good one—pull it out of my hat like a magician does rabbits?"

"Maybe," said Starkey, "the cylinder on the 5076 is not cracked bad as you think."

"It might not be, but I don't want to take the chance. When one of them castings starts cracking, they go fast. If I'd run that engine, the right cylinder would fall off, sure as hell. That happened three years ago on the 5079. The stink raised about it would have made a skunk think he needed a gland operation."

Nevertheless, it was the 5076 or a freight engine, and Evans went out to look it over again. Starkey went with him.

The hostler had the engine on the turntable when the two foremen got there. They waited until the engine was run in the house. Eight above zero was pretty cold to stand around in, anyway.

When the engine was in the house, Starkey told the hostler to apply the brakes and open the throttle a little. When he did, steam hissed through the crack in the cylinder.

"Nope," Starkey shook his head disconsolately, "can't run that way. I'll go see how the boys are getting along on the drop-pit."

Evans stayed at the 5076. He added a hunk of "horse-shoe" big as a hen egg to the cud in his jaw and spat reflectively. One eye closed like he was aiming a gun; he stooped and sighted across the front and back of the cylinders. "That might do it," he spoke aloud to himself, as he started to the storeroom.

Jim was pleasantly surprised to find the things he wanted in the storeroom, two draw bars for 1600 class engines and four three-inch hex nuts and some three-inch round cold rolled steel. He hurried back to the roundhouse and put a machinist and helper at work on the job.

The general foreman came up while Evans was giving

instructions to the machinist. "Looks like a 2800 or nothing." Starkey's voice sounded like he was telling of a recent bereavement.

"Maybe not." Jim's teeth met in a plug of "horseshoe." "I'm going to take a shot at fixing it." He indicated the 5076 with the stub ended thumb of his left hand.

The clerk interrupted further conversation. "The brains wants to know what about an engine for the special, said tell you to be sure and have a good 5000, they're going to be late; hit a snowstorm west of here, want to make the time up."

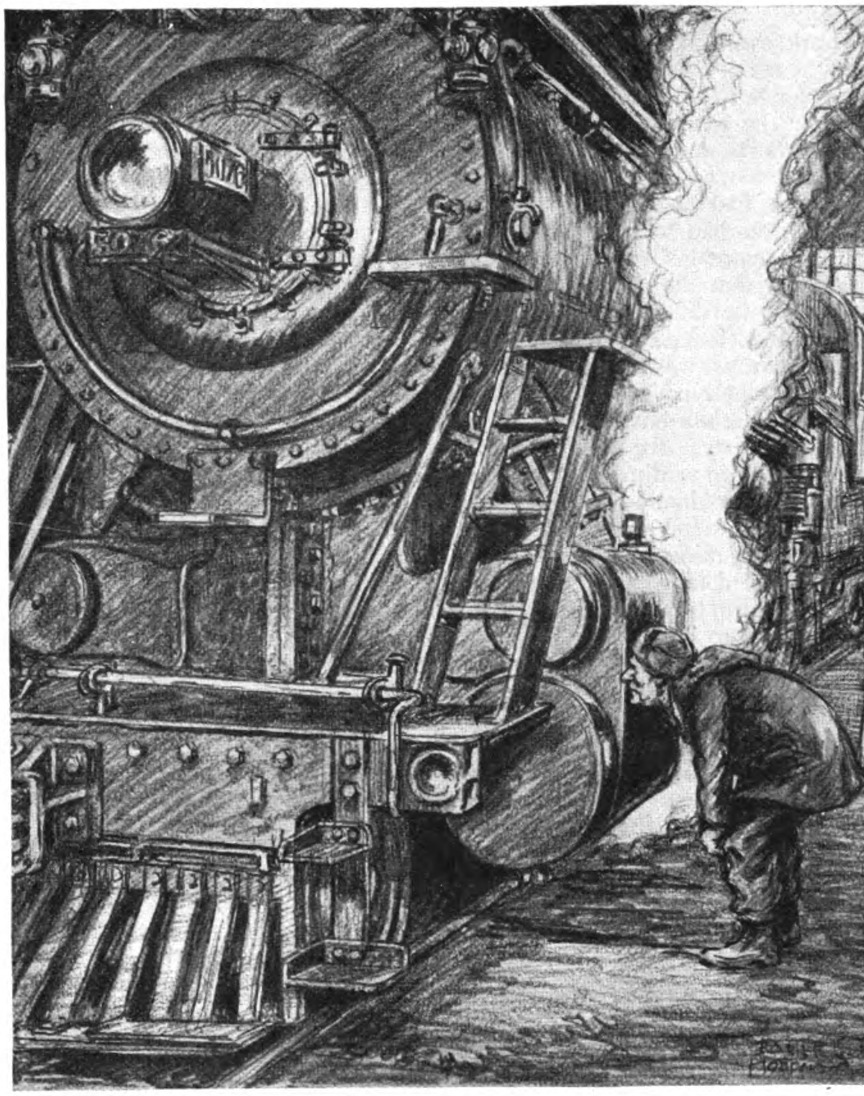
"Tell him the 5076 and tell him if he'll get 'em over the road, we'll get 'em out of the house," Evans snapped.

Harris opened his mouth to say something, changed his mind and went back to the office.

"Dynamo on the 2819 needs a new steam head—froze and bursted." It was Ned Sparks, the electrician. "Not any in the storeroom," he added.

"Get one off the 5082. She's on the drop-pit. Tell the storekeeper to wire for one."

Sparks understood the foreman meant to wire for a dynamo steam head and not for a drop-pit.



One eye closed like he was aiming a gun, he stooped and sighted across the front of the cylinders

THE twelve o'clock whistle blew before Jim realized that the morning was half gone. He rode home to lunch in the car with Starkey. At one o'clock he went to the roundhouse to see how the machinist was getting along on the 5076. The work was progressing nicely. Two other machinists were put to work going over other parts of the locomotive to see that everything was in first-class shape. He had the lubricator set to supply more oil to the cylinders and even told the supply boy to put on an extra quart of engine oil.

"Probably get a letter from the president of the road if he hears about the extra valve oil," Jim remarked, "but I want to be certain she's lubricating."

Evans stayed with the machinist on the job of repairing the 5076 most of the afternoon; that is, he was with him except when answering the phone, showing how various other jobs should be done, O.K.ing requisitions for tools, doing a little engine spotting when the hostler was busy getting engines out, checking work reports, and handing out work slips, and a few other odd jobs that don't count in a roundhouse foreman's twelve-hour tour of duty.

The job on the 5076 was finished shortly before five o'clock. Jacket was removed from cylinders and valves, leaving the castings exposed. The two drawbars were placed lengthwise of the cylinders, one on each side in the depression that marks the junction of the valve chamber and cylinder. A little chipping was necessary for the rectangular bar to fit snugly against the casting. Two three-inch rods of cold rolled steel, threaded on each end, held the drawbars in place, forming in effect a large clamp around the two cylinder castings. The rods were through the holes in each end of the two drawbars. Holes in the drawbars were too large for the three-inch rods, so washers were cut from one-inch boiler plate and slipped over the rods between drawbar and nuts.

Getting the rods in place presented quite a problem. Space was narrow and the opening obstructed so that the rods had to be kinked in several places to go through. A template of half-inch rod was used to get the exact shape of the bends; quarter-inch was tried, but wouldn't hold its shape.

Before the nuts on the rods were drawn up tight, Evans had the machinist drill a small hole at each end of the crack in the casting. This was done to prevent the crack progressing. Round iron plugs were driven in the holes. Nuts on the rods were drawn tight, allowed to stand awhile, and tightened again to take out the stretch.

"Well, it looks like a threshing machine, but I believe it'll hold together," Evans told the general foreman when the job was finished.

Evans just had time before five o'clock to go through the house and see if work was finished on locomotives needed for night trains. It wasn't—there was more work than the handful of men on nights could possibly get done. The unlooked-for job on the 5076 was partly at fault. Two machinists and their helpers were told

to work overtime. That meant more explaining, Evans knew, but no way out of it. The work had to be done if the engines were to run.

After the five o'clock whistle blew, Jim gathered up work reports and slips on jobs to be left for the night men and went to the roundhouse office. Some of the mechanics had neglected to sign work reports for jobs done and he had to go back to the roundhouse to check up. He swore he was going to take the next man out of service that did a job and failed to sign for it, and knew that he didn't mean it.

By six o'clock, things seemed to be in pretty good shape. Evans was taking a well earned rest, feet on desk and pipe burning evenly, when the hostler came in.

"Say, there's a bad air leak on the 2842; she's called for seven-thirty," the hostler said.

Evans swore apathetically and went back to the roundhouse. He told one of the machinists that was working overtime to get some tools and come out to the 2842. After twenty minutes' search, the leak was located. The pipe-fitter had failed to tighten a union on the air reservoir pipe. Jim got his feet thawed out by seven o'clock and time to go home.

Two days later, there was a letter from the superintendent of motive power. The letter said in part: "Performance of engine 5076 on the special was satisfactory. Appearance of the engine was disreputable. Please explain why an engine in such a condition was used on this important train. I want to impress the fact that good appearance of all our engines is important and particularly of passenger equipment. If necessary to use repairs that disfigure our engines, in the future use them only on engines in freight service."

"Well, I'd rather answer that than explain why the train didn't have any engine at all," Jim commented as he took a fresh chew and started out on another twelve-hour day.

Repairing Pneumatic Drills At Pitcairn Shops*

MANY types of pneumatic drills are required at the Pennsylvania Pitcairn (Pa.) air-brake repair shop which handles the work for the Central Region of that system. These will vary from a small ¼-in. maximum capacity drill to the heavy duty close-quarter types which will handle 3-in. drills.

Disassembly of Pneumatic Drills

Upon being received at the shop the pneumatic drills are tested in order to determine what their condition may be and the extent to which they can be operated. They are then dismantled and the parts are thoroughly cleaned in a tank containing a turpentine substitute. In dismantling the protectors are removed from the spindle. The crank caps are removed, then the chamber plates, cylinder heads and exhaust deflectors. On the long-stroke, four-cylinder drills the crank assembly is removed as a unit. In order to do this the rotary valve is removed to release the vacuum behind the pistons. The crank is then turned until one piston is on dead center at the top of the stroke. Then the whole crank is raised and pulled in a direction away from the piston. When the piston slips out of the cylinder further upward movement of the crank is stopped and the crank is moved sideways to remove the opposite piston from the same crank pin. The other pair of pistons is removed in the same manner. To disassemble the crank on this type of drill the taper pins which aline the crank pins and the crank web are driven out and the web pinch bolt is removed. The pinch bolt is screwed in again from the reverse side of the web against the web spreading plate, or a hardened steel plate is inserted in the slot, after which the upper and lower crank ends are removed.

There is another type of four-cylinder drill in which the crank assembly is removed as follows: A pair of

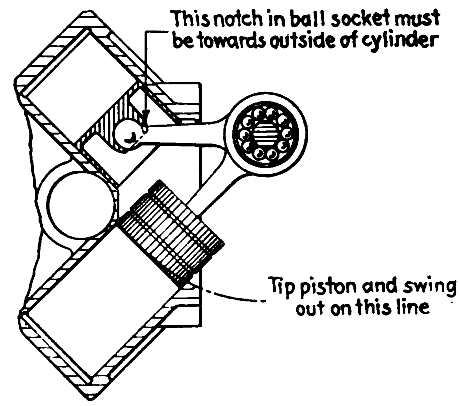


Fig. 1—The method of removing the pistons from the cylinders

long-nose pliers is inserted into the piston and the ends of the pliers inserted in two small holes in the connecting rod springs. The spring ends are then squeezed together and pulled from the piston. After all four springs are loose the crank may be lifted from its place. On still another type of drill the rotary valve is first removed and the pistons are turned in their cylinders until the notch in the ball socket is toward the outside of the cylinder. The crank pin nearest to the pinion is turned to its highest position. The whole crank is lifted upward and, as the pistons attached to this pin are raised in their cylinder, the crank and connecting rod are rocked to one side of the case until one rod enters the notch in the ball socket. The movement is continued until the rod touches both the rim of the piston and the edge of the cylinder. The opposite piston is then removed by tipping and swinging it out of the case as shown in Fig. 1. The first piston is removed by turning the crank pin to the opposite side of the case and pulling it straight out. The remaining pistons are removed in the same manner.

There is still another type of drill which has pistons with cut-away sides. These are removed by turning the crank until one of the crank throws is in the highest position. Then the pistons connected to this throw are turned so that their cut-away sides are toward each other. These two pistons can now be lifted out by pulling on the crank. The remaining two pistons can then be removed in a similar manner. After the crank shaft has been removed from the casing, the top ball race is removed, the crank screw taken out and the crank rollers removed through the screw hole one by one. It is then an easy manner to slip each pair of connecting rods with their bushings over the end of the crank shaft. Certain precautions should be observed when repairing this type of drill. Each crank screw must be put back in the same hole from which it was removed, as they are not interchangeable after having been fitted to any one hole. One type of crank assembly can be taken apart by removing the connecting-rod screw which permits one half of the hinged bearing to open up, allowing the connecting rod to enter the crank.

* This is the seventh of a series of articles dealing with repair work at the Pitcairn air-brake shop.

One type of lever-driven close-quarter drill is disassembled as follows: The gear cover is removed from the top of the cylinder and the bearing cap and bearing spring washer from the bottom of the cylinder. Then all of the case cap screws are removed. The cylinder will come apart and expose the entire operating mechanism. If it is desired to remove the levers, the thrust bearing end is unscrewed and the thrust bearing and its race are removed. The spindle is then pushed out of the cylinder. If a spindle ring is pressed on the lower end of the spindle, then the spindle is driven out with a soft hammer. The levers with pistons attached and with the crank complete may be lifted out. To remove the levers from the crank the bearing nut is unscrewed and the bearing pulled from the lower end of the crank. To remove crank rollers and bushings a pointed tool is used to lift out the spring which holds each split bushing in place. Then the bushing can be removed from the rollers, one at a time, and the rollers removed from the ends of the crank.

Repair Practice on Pneumatic Tools

In repairing pneumatic drills, valve bushings, when worn, are reamed to an oversize sufficient to true them up and oversize valves are lapped in. When valve bushings are cracked or worn or reamed to a size which does not justify further reaming in the judgment of the repair man, they are scrapped. The reverse-valve bushing on reversible type drills is renewable. The worn bushing is removed by inserting a chisel at one side and curling the bushing in; then it may be pulled out. Another method is to tap a thread in the bushing and remove it by inserting a bolt. A new bushing is located radially by its key and pressed in flush with the cylinder case. The bushing is reamed to size after being pressed in place and the reverse valve lapped in. The rotary valve bushing is removed from the upper or feed-screw end and pressed in flush with the bottom of the governor chamber. After being pressed into place it is reamed to take the rotary valve.

The cylinders on some types of drills are ground sufficiently to true them up and oversize pistons are used, the pistons being lapped into the cylinders, while on other types the cylinder bushings are renewed and standard pistons are applied. Pistons are scrapped when they are worn .003 in. below standard cylinder diameter, or if the connecting-rod socket, connecting rod or the rod connections on the piston are broken. When the inside or outside toggle or crank are worn to the extent of .005 in. or if the same amount of wear exists on the inside and outside connecting rod and crank, the necessary parts are renewed to take up the wear. When the connecting-rod socket is worn .003 in., it is scrapped.

When it is necessary to renew any rollers on a crank pin, it is desirable to apply an entire new set to that pin in order to assure uniform diameter of rollers. When it is found necessary to renew a crank screw, the crank is disassembled and a new screw put in place, seating the screw until the locking wire hole or slot is flush with the crank, after which the locking wire is inserted and fastened. The end of the screw is then filed flush with the surface at the crank pin end in order to have the rollers pass without interference. After the rollers have been put in place the repairman should make sure that the crank screw has been turned in the proper distance so that the roller ends will have a flush face to work against. A locking wire is inserted and fastened and care must be taken to see that the position of the screw is not disturbed when adjusting the locking wire.

On certain types of drills, when assembling a crank pinion on a crank, the tooth of the pinion is stamped *0*. This mark is lined up with an arrow stamped on the crank throw just outside the bearing. It is important to see that this is done, as the timing would be affected if the pinion were inserted in the opposite manner.

When assembling the crank on long-stroke, four-cylinder drills the web is spread by means of the pinch bolt referred to in the description of the disassembling operation. This permits the crank pins to slip into place. The crank-pin sleeves, connecting-rod bushings and the connecting rods are then put into place. The upper crank pin has an *X* stamped on the end and there is also an *X* stamped on the center web close to one of the crank-pin holes. The pin is placed in the center web first, from the finished side of the hole so that the *X* marks are adjacent. The lower crank pin is then put into its proper place. The crank-pin sleeves are renewable and are provided with an extension lug which fits into the slot in the web and prevents turning with respect to the crank pin. The crank is then alined by replacing the taper pins which are tapped lightly into place with a hammer. The old taper pins are generally scrapped, as new ones insure perfect alinement. The crank web pinch bolt is then removed and replaced from the opposite side of the web and tightened firmly with its lock nut turned down and fastened by a cotter pin, while the bolt head is held in a vise or by a wrench. The taper pins are then driven firmly into place and the split ends spread. It is important that the pinch bolt be firmly tightened and held while the lock nut is turned in order to prevent the bolt from being loosened, which will place the driving strain on the taper pins. The two crank ends are stamped with the same designating symbol and are assembled together. Care is taken to see that parts of two different cranks are not assembled, as they are not interchangeable. On the majority of the four-cylinder, long-stroke drills the crank is assembled complete before being placed in the drill. On one particular type of drill the one piston is inserted in its cylinder and the crank moved sidewise in order to insert the other piston on the same crank pin. The other two pistons are applied in the same manner.

With respect to the type equipped with connecting-rod springs, all four of the pistons are placed in their cylinders. The crank is put in place with connecting rods and the springs assembled. One spring is inserted at a time, the piston being pushed to the bottom of the cylinder. The crank is rotated until the ball on the connecting rod reaches its seat in the piston. The spring is then pushed down into position by means of a forked tool, a light tap with a hammer assisting in pushing the spring into place. Another type of drill in which there is a notch in the ball socket of each connecting rod is assembled as follows: One piston is placed in the cylinder with the notch toward the outside of the cylinder and the rod entering the notch. At the point where the rod touches both the edge of the cylinder and the rim of the piston the opposite piston is inserted in the cylinder, the notch in the ball socket being turned to the outside of the cylinder. The remaining pair of pistons is applied to the cylinder in the same manner.

When assembling the type of drill having cut-away pistons the pistons are turned so that the cut-away sides are toward each other. With one crank throw in its highest position the two pistons on each throw can be inserted at the same time. A governor is applied to a great many drills for the purpose of preventing excessive speeds when the drill is operated with a very light load or no load at all. This governor is screwed onto the end of the rotary rod and is seldom removed. In case it must be removed, care is taken to see that when it is replaced it is locked in the valve again. On some types

of drills this is done by peening the lower end of the thread on the governor. This can be done by working through the two exhaust ports near the end of the valve. On another type of drill the locking is accomplished by center punching the flange on the governor body in the two milled slots on the end of the rotary valve. To remove the governor from the valve a wrench made to fit the hexagon hole in the governor is used. Only the specified springs for each type of governor are used.

On certain types of drills the rotary-valve pinion is too large in diameter to pass through the bushing and is made separate from the valve. The pinion is removed in preference to the governor when it is desired to remove the valve from the drill.

Gears are renewed when broken or badly worn. Radial thrust bearings which take the spindle thrust are assembled with the side of the outer race stamped for thrust down or toward the spindle. The bearing is always assembled with a movable race toward the spindle.

On the lever-driven, close-quarter drills the assembly is accomplished as follows. It is necessary to hold back the ratchet pawls with a screw driver or similar tool while passing the spindle through the levers. This is most easily accomplished by starting the spindle through

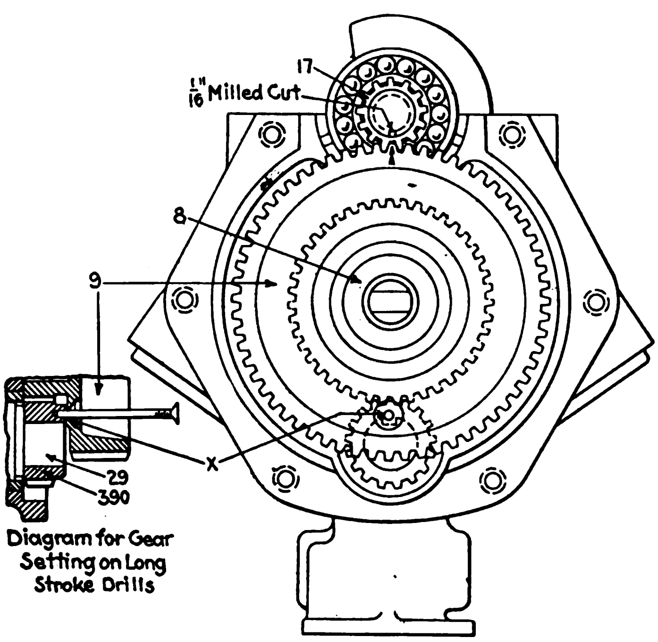


Fig. 2—Valve timing and gear setting

the cylinder until it strikes the first pawl and then turning the entire drill up and resting the piston end of the cylinder on the bench so that the whole weight of the cylinder and lever falls on the first pawl. Each pawl is then released with a convenient tool, permitting the lever to drop down over the spindle. The pistons are inserted in the cylinder bores, one at a time, beginning with either outside piston. The repairman should make sure that the lower bearing ring is in position before replacing the bearing cap.

Valve Timing and Gear Setting

Fig. 2 shows a diagram for gear setting on one type of long-stroke drill. The spindle gear (part No. 9) is inserted so that the arrow stamped on one of the teeth engages the tooth space on the crank pinion (part No. 17) marked by a 1/16-in. milled cut. A wire or nail is inserted in the hole in the spindle gear web marked *X* on the drawing and the rotary valve is turned until the wire engages the hole in the top of the valve (part No. 29) then the teeth are meshed. In order to assemble the gears on this type of drill it is necessary to set the intermediate gears properly. This is done when the gear frame with the three intermediate gears assembled is placed in the gear case. The *X* stamped on each intermediate gear is lined up with the marks which are stamped 120 deg. apart on the spindle gear.

Fig. 3 illustrates the method of setting the valves on an older type of drill. In this case it is only necessary to see that the letters stamped on the crank pinion and the valves register with those stamped on the spindle gear. The two rotary valves are interchangeable.

The valve timing and the assembling of the gear on

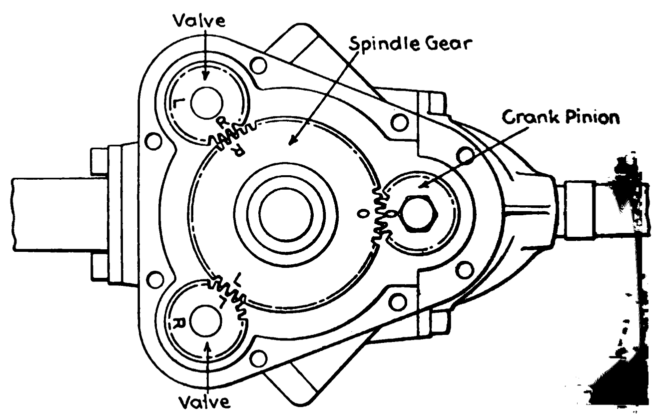


Fig. 3—The manner in which the valves are timed on this type of drill

gear-driven, close-quarter drills is accomplished as follows. The rotary valve is inserted in its bushing in the assembled cylinder and the valve shaft is placed in the valve. The valve-shaft pin will fit into the valve in two positions, either one being correct. Next the crank is rotated until a small drilled hole in the upper crank web comes directly under the milled notch in the case cover flange on the case. The end of one gear tooth on the valve shaft has the end beveled off. With the crank in the above-described position the cylinder is placed in

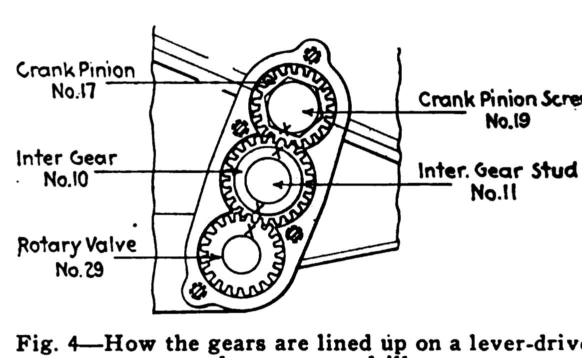


Fig. 4—How the gears are lined up on a lever-driven close-quarter drill

the case and, while this is being done, the valve-shaft gear is meshed with the gear on the center web of the crank so that the bevel on the tooth comes directly under another milled notch in the flange on the case cover.

To assemble the gears the spindle is placed with its bearing on it in the case. The lower drive shaft is then assembled in the case by inserting the bottom plate first and then the roller-bearing race. Next the rollers are set in with grease and finally the top plate is put in position. The drive-shaft pinion gear spacer and drive-

shaft gear are then placed in position in the machine and the drive shaft with the upper bearing assembly on it is pushed through them until the lower end enters the lower bearing. Next, the intermediate shaft, with its bearing, bearing spacer and gear assembled on it, is inserted in the drill from the lower side. The crank is then assembled with its bearing and pinion and dropped into position from the top.

To time the valves on lever-driven, close-quarter drills it is necessary to line up the gears as shown in Fig. 4. The stamped teeth on the intermediate gear (No. 10) engage the tooth spaces on the crank pinion (No. 17) and the rotary valve (No. 29).

New bodies are not used in making repairs as the cost does not justify the practice. Parts of old drills retained after the bodies are scrapped are used in making repairs to other drills of the same type when they are suitable. Pneumatic drill bodies are scrapped when

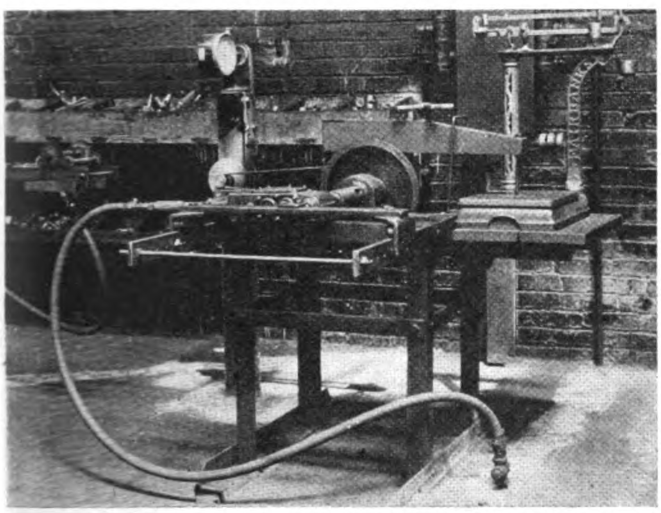


Fig. 5—Test device for determining the efficiency of repaired pneumatic drills

cracked or when they are so badly dented that the dents cannot be removed sufficiently to permit proper repairs to the drill. Housings are reclaimed by re-cutting threads and using oversize packing nuts when threads are damaged. While pneumatic drills are being removed, they are lubricated with a special air-motor grease.

Testing Pneumatic Tools

After the drills have been repaired they are subjected to a test to determine whether or not they are capable of performance equal to the manufacturer's rating. The device used for testing drills is shown in Fig. 5. This device is equipped with a tachometer to indicate the speed of the drill spindle, as well as a Tool-om-eter for indicating the consumption of air in cubic feet per minute. The brake horsepower of the drill under test is calculated by the formula

$$\text{Hp.} = \frac{2\pi \times r \times l \times \text{r.p.m.}}{33{,}000}$$

in which

r = the length of the brake arm in feet (1.575 ft.)
l = the weight required to balance the downward pressure of the brake arm
r.p.m. = revolutions per minute as shown by the tachometer

The following table gives the results of a test on a four-cylinder drill which will illustrate the method of calculating the horsepower. The free running speed of the drill is 410 r.p.m., with an air consumption of 66 cu. ft. per min. As the load on the brake arm was increased the following values were indicated:

Weight, lb.	R.p.m.	Ft. lb.
20	260	5,200
25	225	5,625
30	190	5,700
35	170	5,950
40	150	6,000
45	130	5,850

It will be noted from the above table that the best performance was indicated at a weight on the brake arm of 40 lb. Calculating the horsepower by the above formula, the result is 1.80, which compares favorably with the manufacturer's rating of 1.84 for this type of drill. Any pneumatic drills which fail to compare favorably with the manufacturer's power rating are re-examined to determine the cause of their poor performance.

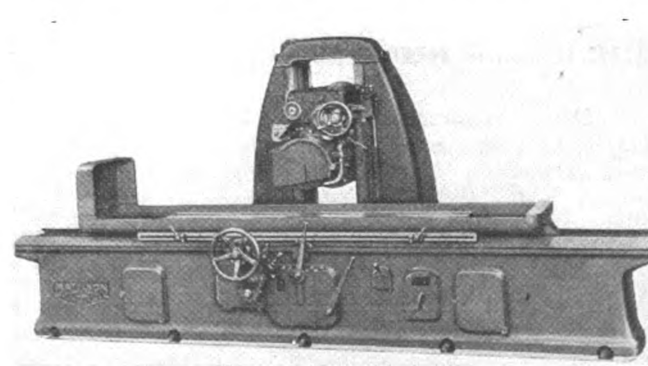
When the drills have passed the tests satisfactorily, they are packed for shipment and the necessary records are entered as to type, date of repairs, etc. Approximately 80 pneumatic drills are repaired at the Pitcairn shop each month.

High-Power Precision Surface Grinder

A LINE of high-power precision surface-grinding machines with hydraulic feeds which has been developed by the Mattison Machine Works, Rockford, Ill., apparently is well adapted to a railway shop use. In the smaller sizes, for example, with a table working surface 12 in. by 4 ft., vertical head adjustment of 16½ in., and 14-in. diameter wheel, this machine should give effective service for many miscellaneous surface-grinding operations in railway tool rooms and machine shops. In the larger sizes, for example, with a table working surface 24 in. wide by 7 ft. long, or more if required, the machine is well adapted for grinding locomotive rod sections, guide bars, link sides, shear blades, and thin castings, such as journal boxes which can be set up in multiple for light finish-machining operations.

An outstanding characteristic of the Mattison surface-grinder is the powerful built-in motor construction, with the rotor mounted directly on the wheel spindle and balanced as a unit. With this positive and direct form of drive, no vibration is imparted to the wheel spindle, as may be the case with belts, chains, gears or other drive connections.

To remove stock successfully with a grinding wheel it is necessary to maintain full power. When the wheel slows down, due to slippage, cutting efficiency is lowered



One of the Mattison high-power precision surface grinders of a size adapted to grinding locomotive guide bars

and capacity and quality suffer. On the Mattison machine, the motor delivers its full power direct to the wheel and there is ample reserve to insure full wheel speed for fast grinding.

The wheel spindle with its totally enclosed, built-in motor, is mounted in heavy housing which is carried on the horizontal ways of the wheel slide assembly. This wheel slide assembly is in turn supported between two substantial columns having large taper-gibbed ways. This design affords a strong and secure support for the working parts.

Longitudinal table travel is hydraulically operated. The stroke is adjustable to cover any portion of the table up to its maximum by a simple setting of the table reversing dogs. Table speed ranges from 30 ft. to 100 ft. per minute. The transverse feed of the wheel is also hydraulically operated, movement being entirely automatic when grinding. Feed is variable up to 1¾ in. at each reversal of the table. Both quick-acting and low-geared cross feeds, with automatic reversal, can also be operated by handwheel, either for grinding or wheel truing.

Operating and adjusting levers, handwheels and electric push buttons are closely concentrated on the front of the machine, all within convenient reach of the operator. Raising the wheel from the work is done electrically and the controlling push button is located in the end of the clutch lever. With one movement the hoisting motor is started and the power clutch is engaged. The downward movement of the wheel is controlled by a separate push button which is so arranged that the travel continues only while the operator keeps the button depressed. This permits spotting the wheel just above the work. Final adjustment for grinding is made by a handwheel and stop, with micrometer graduations of .0001 in. The reversing of the wheel slide traverse is accomplished automatically, both on hand and hydraulic feeds, by two dogs on a circular disk, easily adjustable and located directly in front of the operator. This mechanism also serves as a quick means for locating the wheel in the center of the work.

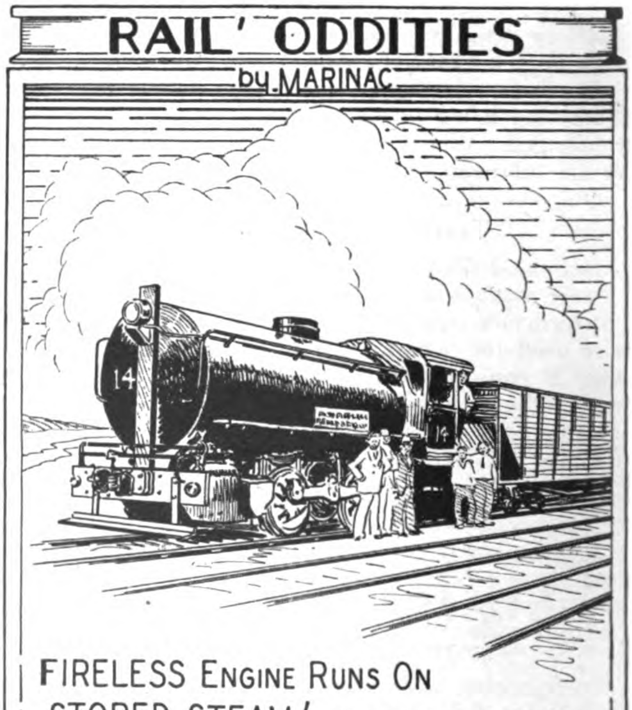
Increased production, together with savings in grinding costs, are direct results of the generous size of this Mattison surface grinder. Being able to fill the table or magnetic chuck with a large number of parts per set-up, together with a 6-in. face wheel increases capacity Work hitherto ground with narrow wheels on small, light machines, can be ground much faster and with greater accuracy on this high-powered Mattison surface-grinder.

Diesel Engine Questions and Answers

19. *Q.—In connection with Diesel engines what is the cause of excessive exhaust temperature and what causes low scavenging pressure? How does the condition of the valves affect this?* A.—The exhaust temperature will be affected by the completeness of combustion and the expansion following combustion. A low exhaust temperature is an indication that the heat of combustion has been more completely converted into power or absorbed by the circulating water in the jackets or pistons. If too much fuel is injected or combustion is late or delayed, the heat generated during the power stroke may not be fully converted into power and the exhaust gases will then contain more heat units than they should and this will be indicated by a higher than normal exhaust temperature. Also, if the exhaust opens too soon by reason of improper adjustment, this also would cause a higher exhaust temperature. Delayed combustion may be caused by faulty admission of the fuel and defective air mixture. Leaky fuel injection valves or improper adjustment may be the cause. Leaky piston rings also may have some effect, as this detracts from the ability of the piston to absorb the power from the expansion of the gases during the power stroke and will also cause some loss of compression. The exhaust-gas temperature will rise to some extent with increase in power as there is a greater amount of heat to be converted. However, at low power an extremely low exhaust temperature may not be an indication of efficiency but may be caused by an excess of jacket cooling which takes away some of the heat which should be converted into mechanical energy. Low scavenging pressure is most likely caused by defective or inadequate scavenging pumps. However, there is no particular gain in efficiency by having the scavenging pressure too high. This will increase the power, if enough fuel is injected. Leaky valve or other maladjustment of the scavenging pump, such as leaky pistons or other leaks, improper speed in case of a rotary blower and various other defects may account for a loss of pressure for the scavenging system. The remedy for above defects is to see that all parts are in proper adjustment and that the pistons, valves, etc., are kept tight.

20. *Q.—In a Diesel engine, what does smoky exhaust indicate?* A.—A smoky exhaust indicates that the engine is overloaded or the injection of fuel is not timed properly. This condition also may indicate that the oil may be of inferior quality.

* * *



For explanation see page 88.

Among the Clubs and Associations

Car Foremen's Association of Chicago.—The A. A. R. Rules of Interchange will be discussed at 8 p. m. on February 10 at the La Salle Hotel, Chicago.

Car Foremen's Association of Omaha, Council Bluffs and South Omaha Interchange.—The A. A. R. rules and their changes will be discussed at the February 13 meeting, which will be held at 1:15 p. m. at the Union Pacific shops, Council Bluffs, Iowa.

New England Railroad Club.—E. K. Bloss, supervisor rail motor car maintenance of the Boston & Maine, will deliver a paper on Diesel engines at the February 11 meeting, which will be held at the Copley-Plaza Hotel, Boston, Mass., beginning with dinner at 6:30 p. m.

Directory

The following list gives names of secretaries, dates of next regular meetings and places of meetings of mechanical associations and railroad clubs:

Air-Brake Association.—T. L. Burton, c/o Westinghouse Air Brake Company, 3400 Empire State Building, New York.

Allied Railway Supply Association.—F. W. Venton, Crane Company, Chicago.

American Railway Tool Foremen's Association.—G. G. Macina, 11402 Calumet avenue, Chicago.

American Society of Mechanical Engineers.—C. E. Davies, 29 West Thirty-ninth street, New York.

Railroad Division.—Marion B. Richardson, 192 East Cedar street, Livingston, N. J.

Machine Shop Practice Division.—G. F. Nordenholt, 330 West Forty-second street, New York.

Materials Handling Division. — F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

Oil and Gas Power Division. — M. J. Reed, 2 West Forty-fifth street, New York.

Fuels Division.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

Association of American Railroads. — J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

Division I. — Operating. — Safety Section.—J. C. Caviston, 30 Vesey street, New York.

Division V.—Mechanical.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

Committee on Research.—E. B. Hall, chairman, care of Chicago & North Western, Chicago.

Division VI.—Purchases and Stores.—W. J. Farrell, 30 Vesey street, New York.

Division VIII.—Motor Transport.—Car Service Division.—C. A. Buch, Transportation Building, Washington, D. C.

Association of Railway Electrical Engineers.—Jos. A. Andreucetti, C. & N. W., 1519 Daily News Building, 400 West Madison street, Chicago, Ill.

Canadian Railway Club. — C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

Car Department Officers Association.—A. S. Sternberg, master car builder, Belt Railway of Chicago, 7926 South Morgan st., Chicago.

Car Foremen's Association of Chicago.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago, Ill.

Car Foremen's Association of Omaha, Council Bluffs and South Omaha Interchange.—J. R. Leach, car department, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p.m. at Union Pacific shops, Council Bluffs.

Central Railway Club of Buffalo.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

Eastern Car Foremen's Association. — E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

Indianapolis Car Inspection Association. — R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

International Railway Fuel Association. — T. D. Smith, 1660 Old Colony Building, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 West Wabasha street, Winona, Minn.

International Railway Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

Master Boilermakers' Association.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, excepting June, July, August and September, at Copley-Plaza Hotel, Boston.

New York Railroad Club.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

Northwest Car Men's Association. — E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium Building, St. Paul.

Pacific Railway Club.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately—June, in Los Angeles and October, in Sacramento.

Railway Club of Greenville. — J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

Railway Club of Pittsburgh.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

Railway Fire Protection Association.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md.

Railway Supply Manufacturers' Association.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

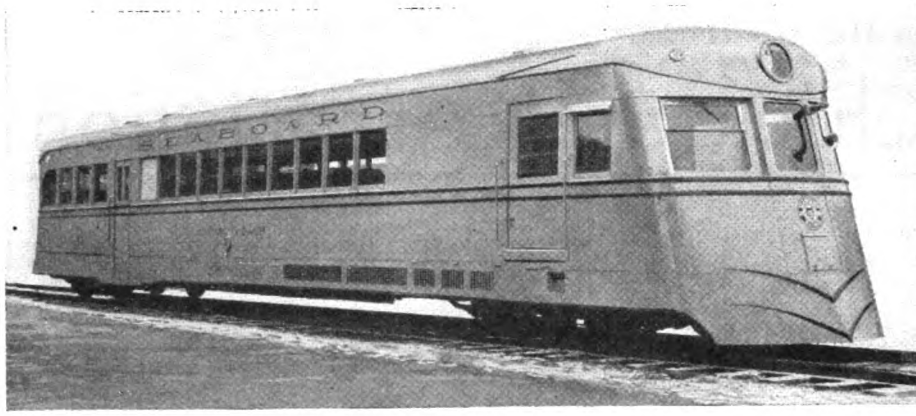
Southern and Southwestern Railway Club.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

Toronto Railway Club.—R. H. Burgess, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August.

Traveling Engineers' Association.—J. M. Nicholson, president, Kansas City, Mo.

Western Railway Club.—C. L. Emerson, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

Exhibition of Model Engineers.—The eighth annual exhibition of the New York Society of Model Engineers, Inc., will be held from February 7 to 22, inclusive, at the club rooms of the society on the third floor of the Knickerbocker Building, 152 West Forty-second street, New York. The exhibition will be open from 1 p. m. to 10:30 p. m. every weekday, and an admission fee of 25 cents will be charged. The illustration is representative of the society's model railroad layout. It shows a section of the ¼-in.-to-the-foot scale right-of-way of the road, which is known as the Union Connecting Railroad. Much of the 400 ft. of operating track of this model layout is main line.



One of three rail-motor cars built by the American Car and Foundry Company for the Seaboard Air Line

NEWS

Decorated Dining Cars

THE Pennsylvania has just put in service a dining car the interior of which is decorated with the coats of arms of thirteen states and the District of Columbia—that is to say, the territory traversed by the company's lines. The car will be assigned to different trains for short periods, so that it may be displayed to all parts of this railroad company's public. These emblems have been painted by hand and appear in the panels between the windows and in the end panels. They are the symbols of New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Kentucky, Ohio, Indiana, Michigan, Illinois, Missouri and the District of Columbia.

Chicago Chapter of Historical Society To Be Formed

PRELIMINARY steps toward the organization of a Chicago chapter of the Railway and Locomotive Historical Society were taken at a recent meeting, when members residing in Illinois, Wisconsin and Indiana elected officers and applied to the national headquarters for a charter. Officers chosen for the Chicago chapter are: Chairman, Carlton J. Corliss, assistant in public relations of the Illinois Central; vice-chairman, A. W. Johnson; secretary, Delmar W. Youngmeyer; treasurer, A. Osterholm. The objectives of the society are historical research and the preservation of railway records of permanent interest. The headquarters of the society are in the Baker Library, Boston, Mass.

Burlington Orders Two More Zephyrs

Two more Zephyrs—"Denver Zephyrs"—have been ordered by the Chicago, Burlington & Quincy from the Edward G. Budd Manufacturing Company. They will be placed in service between Chicago and Denver, Colo., in June, on a schedule of 16 hr. for the 1,039 miles. The proposed schedule of the new trains is 11 hr. 45 min. faster than the present westbound, and 9 hr. 15 min. faster than the present eastbound schedules. The average running speed between Chicago and Denver will be approximately 65 m.p.h., including six or seven stops en route.

The train, which will have a capacity for 200 persons, will contain 10 cars, having an exterior width of 10 ft. The first car will probably be a combination baggage and power car, and the second car a combination passenger-baggage car. The remaining eight cars will include a reclining chair car, four sleeping cars, a club car, a dining car and an observation car. Each train will be hauled by a Diesel-electric locomotive in two vehicle units. Articulation will be applied between cars three, four and five; six and seven; and eight and nine. All other cars and the two locomotive units will have two trucks each.

With the inauguration of the Denver Zephyrs, the Burlington Zephyr mileage per day will total 4,784. This will include 2,078 miles between Chicago and Denver, 1,764 miles between Chicago and the Twin Cities, 441 miles between St. Louis, Mo., and Burlington, Iowa, and 500 miles between Lincoln, Neb., and Kansas City, Mo. The latter four Zephyrs, up to the beginning of 1936, had operated a total of 697,687 miles.

Purdue Dean to Head American Engineering Council

DR. A. A. POTTER, dean of the Schools of Engineering, Purdue University, has been unanimously nominated as president of the American Engineering Council for 1936 and 1937, to succeed J. F. Coleman, of New Orleans. Dean Potter is a past-president of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education, the Indiana Engineering Society and the Kansas Engineering Society, which are member bodies of the national Council.

Three Rail Motor Cars for Seaboard Air Line

THE Seaboard Air Line has received from the Berwick plant of the American Car and Foundry Company three lightweight rail-motor cars, designed for single-unit operation. The cars weigh 52,000 lb. in working order and, including a revenue load of 57 passengers and 5,000 lb. of baggage, weigh 65,550 lb.

The overall length of the cars is 64 ft. 1 in., and the height from the rail to the top of the roof is 10 ft. 5 in. The maximum width over the side posts is 9 ft., and the inside height from floor to ceiling is 7 ft. The interior is divided into three compartments, one for baggage and two passenger compartments, one for white passengers and one for colored passengers. The cars are of streamline design with a well rounded front containing three large windows fitted with shatterproof plate glass. The rear end is of the beaver-tail type and contains two large windows.

The superstructure is of steel-frame construction with aluminum side sheets and letter boards, wood floors and a wood roof covered with Mulehide. The entrance vestibule is of the center type and is located between the two passenger compartments.

The power plant is mounted entirely beneath the floor. The engine is a six-cylinder horizontal Hall-Scott Model 180, developing 176 hp. at 2,200 r.p.m.

The car body is mounted on an A. C. F. Model 96-AM-2 drive truck at the front end and a Model 96-AT-2 trailing truck at the rear end. The brake rigging is of the outside-hung type on the drive truck and of the inside-hung type on the trailer.

The air-brake equipment is the Westinghouse semi-automatic type with mechanically driven compressor having an unloading device and with self-lapping hand-operated brake valve, with both hand and foot operated safety control. The brake cylinder for the front truck is of the body-hung type, and that for the trailing truck is mounted on the truck itself.

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Equipment Orders

Road	No. ordered	Type	Builder
Locomotives			
C., B. & Q.	3	4-8-4	Company shops
N. Y., N. H. & H.	5	660-hp. Diesel-elec. switchers	Cooper-Bessemer Corp.
	5	600-hp. Diesel-elec. switchers	Ingersoll-Rand Co.
S. A. L.	1	0-4-0 switch	Baldwin Locomotive Works
	6	16,000-gal. tenders	Baldwin Locomotive Works
Cars			
Bangor & Aroostook	50	50-ton rack	Magor Car Corp.
C., B. & Q.	500*	Box	Havelock Uebraska shops
	2†	10-car trains	Edw. G. Budd Mfg. Co.
	2‡	7-car Diesel-elec. trains	Edw. G. Budd Mfg. Co.
Paulista Ry. of Brazil	400	45-ton, all-steel box	Pullman-Standard Car Exp. Corp.

* In addition to 500 being constructed at Galesburg, Ill., shops.
† Exclusive of motive power. The cars are to be of light-weight stainless steel.
‡ To consist of a dining car, a cocktail lounge, a parlor car, an observation car, and coaches; 10 ft. wide; stainless steel.

Personnel Changes in National Railroad Adjustment Board

L. O. Murdock, assistant to the executive vice-president of the Chicago, Burlington & Quincy, in charge of labor matters, has been appointed a member of Division 3 of the National Railroad Adjustment Board, to succeed E. W. Fowler, who has been transferred to Division 1, to replace Macy Nicholson, who has resigned.

R. A. Knoff, superintendent of the labor and wage board of the Central region of the Pennsylvania, with headquarters at Pittsburgh, Pa., has been appointed a member of Division I of the Adjustment Board.

Supply Trade Notes

The Armco Railroad Sales Company, Middletown, Ohio, has moved its Philadelphia, Pa., office to the Lincoln-Liberty building, Broad and Chestnut streets.

Charles G. Durfee, manager, systems department of the Pyrene Manufacturing Company, Newark, N. J., has been appointed assistant to Edward G. Weed, vice-president in charge of sales.

David S. Wright, of the department of inspection and metallurgy of the Indiana Harbor works, Indiana, of the Inland Steel Company has been transferred to the sales department with headquarters at St. Paul, Minn.

The National Malleable and Steel Castings Company, Cleveland, Ohio, has moved its Philadelphia, Pa., office from 1600 Arch street to 1140 Broad Street Station, 1617 Pennsylvania Boulevard.

Thomas N. Armstrong, Jr., has joined the technical staff of The International Nickel Company, Inc., New York. Mr. Armstrong, who will handle the steel castings development for the company, will operate out of the New York office.

L. F. Sweeney has been appointed assistant to the vice-president of the Standard Stoker Company, Inc., Chicago, succeeding C. T. Hansen who has been appointed district sales manager to succeed R. J. Schlacks, resigned.

The DeVilbiss Company, Toledo, Ohio, training school for painters and others interested in learning the technique of spray-painting, and the use and care of spray-painting equipment, will be open for periods of one week beginning February 10, March 9, April 6, May 4 and June 8.

J. B. Spencer, vice-president of the Southern Wheel Company, a subsidiary of the American Brake Shoe & Foundry Company, has been elected president of the Ramapo Ajax Corporation, also a subsidiary of the American Brake Shoe Company. Mr. Spencer's headquarters are at New York.

The Markham Supply Company, Chicago, has been appointed general railway sales representative for the Chicago, St. Louis, Mo., Kansas City, Omaha, Neb., and Twin Cities territory for the Babcock & Wilcox Tube Company, Beaver Falls, Pa. Lloyd R. Wells, formerly railway sales representative of the latter company, will continue in the same capacity with the Markham Supply Company.

The United States Steel Corporation, New York, has created three additional vice-presidencies, and appointed to such offices the following: Harold L. Hughes, vice-president, with executive duties assigned by the president; W. A. Forbes, vice-president, with supervision over by-product coke plants and disposition of their products, and Charles H. Rhoades, vice-president, with supervision over purchases.

The Republic Steel Corporation has moved its general offices from Youngstown, Ohio, to the Republic Building, Cleveland, Ohio. The move consolidates the general offices which have been located in Youngstown, the executive and the Cleveland district sales offices in Cleveland and the advertising department at Massillon, Ohio. The sales offices of the Newton Steel Company will also be located in Cleveland. The sales offices of the alloy steel division of Republic will remain in Massillon, Ohio.

Obituary

William J. Piersen, western sales manager of the Adams & Westlake Company, Chicago, died at Evanston, Ill., on January 12.

Harry L. Horning, president and founder of the Waukesha Motor Company, Waukesha, Wisc., died at Battle Creek, Mich., on January 4.

Harry Daniels, manager of the railroad department of the West Disinfecting Company, died on January 19, at Evanston, Ill., of bronchial pneumonia.

J. Alfred Dixon, vice-president of the Safety Car Heating & Lighting Company and president of the Pintsch Compressing Company, New York, died on January 13. Mr. Dixon was born on May 26, 1867, at East Orange, N. J. He received his early education at the Ashland School in East Orange; he then attended Steven's Preparatory School and was graduated in 1891 from Steven's Institute of Technology, at Hoboken. Mr. Dixon entered the employ of the Safety Car Heating & Lighting Company immediately after his graduation and later was placed in charge of construction of Pintsch gas plants throughout the United States. He was subsequently made vice-president and general manager of the Pintsch Compressing Company and since 1919 had served as president of that company, which is a subsidiary of the Safety Car Heating & Lighting Company. He also had served since June, 1912, as a vice-president of the Safety Car Heating & Lighting Company. At the time of his death, Mr. Dixon was also a member of a number of technical associations and clubs.

Personal Mention

General

J. F. Johnson has been appointed inspector of tests of the Florida East Coast, with headquarters at St. Augustine, Fla.

H. N. Smith, master mechanic of the Canadian National at Saskatoon, Sask., has been appointed acting superintendent of motive power and car equipment.

C. S. Taylor, master mechanic of the Atlantic Coast Line at South Rocky Mount, N. C., has been appointed superintendent motive power, Northern Division, with headquarters at South Rocky Mount.

E. L. Bachman, master mechanic of the Pennsylvania, with headquarters at Harrisburg, Pa., has been appointed acting superintendent motive power of the Eastern and Central Pennsylvania division, succeeding H. H. Haupt.

W. S. Lammers, assistant mechanical valuation engineer of the Atchison, Topeka & Santa Fe, has been appointed mechanical valuation engineer, with headquarters as before at Topeka, Kan.

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Master Mechanics and Road Foremen

W. B. MIDDLETON has been appointed master mechanic of the Atlantic Coast Line, with headquarters at South Rocky Mount, N. C.

GEORGE C. JONES, master mechanic of the Atlantic Coast Line at Jacksonville, Fla., has had his jurisdiction extended to include the Jacksonville district and Sanford, Fla., shops.

W. ALEXANDER, locomotive foreman of the Canadian National at Transcona, Man., has been appointed acting master mechanic, with headquarters at Saskatoon, Sask., succeeding L. G. Robin, retired.

Shop and Enginehouse

R. M. WILSON has been appointed shop superintendent of the Erie, with headquarters at Hornell, N. Y.

A. B. MCKINNEY, night foreman of the Canadian National at The Pas, Man., has been promoted to the position of locomotive foreman at The Pas.

M. CARROLL, enginehouse foreman of the Atlantic Coast Line, has been promoted to the position of general foreman, with headquarters at Sanford, Fla.

Obituary

LEON M. JONES, who served as purchasing agent of the Norfolk Southern from 1913 until his retirement January 1, 1932, died at his home in Princess Anne County, near Norfolk, Va., on January 1, at the age of 66.

H. R. STEVENS, master mechanic of the Atlantic Coast Line at Sanford, Fla., died on January 3. Mr. Stevens began his railroad career with the Central of New Jersey in 1882 as a machinist apprentice. In 1888 he became a machinist on the Erie, later becoming a gang foreman of the New York, Susquehanna & Western. He entered the employ of the Atlantic Coast Line in 1900 as a general foreman at Rocky Mount, N. C. On September 23, 1903, he was appointed master mechanic at Sanford.

FRANK H. ADAMS, mechanical valuation engineer of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan., died on January 6. Mr. Adams was born on April 15, 1866, at Woodville, Mass., and obtained his higher education at the University of Minnesota. He entered railway service in 1887 as a special apprentice on the St. Paul & Duluth (now part of the Northern Pacific). In 1891 he entered the service of the Gulf, Colorado & Santa Fe (part of the Atchison, Topeka & Santa Fe System) as chief draftsman, serving in this position until 1901, when he was appointed engineer of shop extensions of the Santa Fe. From 1914 to 1921, Mr. Adams served as senior mechanical engineer of the Bureau of Valuation of the Interstate Commerce Commission, Western district, with headquarters at Kansas City, Mo. Since 1921 he had held the position of mechanical valuation engineer of the Santa Fe at Topeka.

W. O. THOMPSON, who retired in 1930 as equipment assistant of the New York Central, died on January 5 at Cleveland, Ohio. Mr. Thompson was born at Candaque, Mich., in 1860, and entered railway service as a section laborer on the Fort Wayne, Jackson & Saginaw (now part of the New York Central). Mr. Thompson then served successively as an apprentice for the Michigan Central, as a fireman and locomotive engineman for the Fort Wayne, Jackson & Saginaw, as a traveling engineer and engine dispatcher for the Lake Shore & Michigan Southern (now part of the N. Y. C.), and as a master mechanic for the Toledo, St. Louis & Western (now part of the New York, Chicago & St. Louis), and in the following positions on the New York Central: General locomotive inspector, district superintendent motive power and rolling stock, master car builder, superintendent

W. O. Thompson

rolling stock, general superintendent rolling stock and equipment assistant. At the time of his death, Mr. Thompson was secretary of the Traveling Engineers' Association, president of the New York Central Railroad Mutual Relief Association, and first vice-president of the Central Railroad Men Savings & Loan Association.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

BOILER TUBES.—The Bethlehem Steel Company, Bethlehem, Pa., has issued a four-page folder, No. 338, descriptive of Bethlehem 4.5 boiler tubes.

PIPE TOOLS.—The four-page bulletin issued by Beaver Pipe Tools, Warren, Ohio, describes a new Model-A special pipe machine having a capacity to cut all sizes of pipe from ⅛ in. to 2 in.

DIRECT READING DIALS.—The Monarch direct length reading dial is described and illustrated on the catalog insert, Bulletin S-7, issued by the Monarch Machine Tool Company, Sidney, Ohio.

HIGH TENSILE STEEL.—The average physical properties of Armco H.T.-50, a special high-tensile steel which permits the use of advanced methods of fabrication and welding processes, are tabulated in a four-page folder of useful facts issued by the American Rolling Mill Company, Middletown, Ohio. The steel is especially suitable for many types of railroad equipment.

DIESEL SWITCHING LOCOMOTIVES.—An attractive 36-page, spiral-bound booklet describing Diesel electric locomotives for switching service has been issued by the American Locomotive Company, New York. Following an account of the company's entrance into the field of Diesel locomotive development, operating data on several different 600-hp. locomotives are given. The trucks and the Alco type Diesel railway engine and its parts are then described, and specifications and performance curves for 300-, 400-, 600- and 900-hp. switchers given. The illustrations show clearly many details of construction.

MARINAC'S RAIL ODDITIES

MARINAC has furnished us with the following explanations of the three cartoons which appear elsewhere in this issue:

Page 57. The sixteenth century "Gold Mine Lorry" used in a Hungarian mine was still in service in 1890. The lorry, as well as the rails and wheels, is made of wood and is on exhibition at the Berlin Transport Museum—quite a step from our present-day electric mining cars.

Page 65. John D. Lamey, of Hoquiam, Wash., living near a railroad, was required to walk five miles to town each day. He decided that if the railroad would not furnish him with a train he would construct one for himself. The result was a composition of a bicycle frame, a few pieces of steel tubing, plus his inventive ingenuity and four papier mache wheels—and the one-man train was developed.

Page 84. The largest fireless switching locomotive ever built was for use at the Brooklyn Navy Yard. Containing no firebox it runs on stored steam. The huge tank, resembling the boiler of an ordinary locomotive, is periodically filled with steam from a stationary plant. Steam pressure of 200 lb. is built up at the time of charging, and the switcher will operate successfully until the pressure falls below 50 lb. This drop does not usually occur for several hours. The charging operation consumes about 20 min. less time, it is estimated, than is required for a conventional engine to take on coal and water and clean out the fire and ash pans.

Railway Mechanical Engineer

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With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic. Name Registered, U. S. Patent Office

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Stainless Steel

Coach for the Santa Fe

Built with de luxe facilities for long-distance travel by the Edward G. Budd Manufacturing Co., the car weighs less than 42 tons, ready for service — Full center-sill strength requirements are met

A light-weight passenger coach, the body of which is fabricated of stainless steel by the Shotweld process, has been delivered to the Atchison, Topeka & Santa Fe by the Edward G. Budd Manufacturing Co., Philadelphia, Pa.

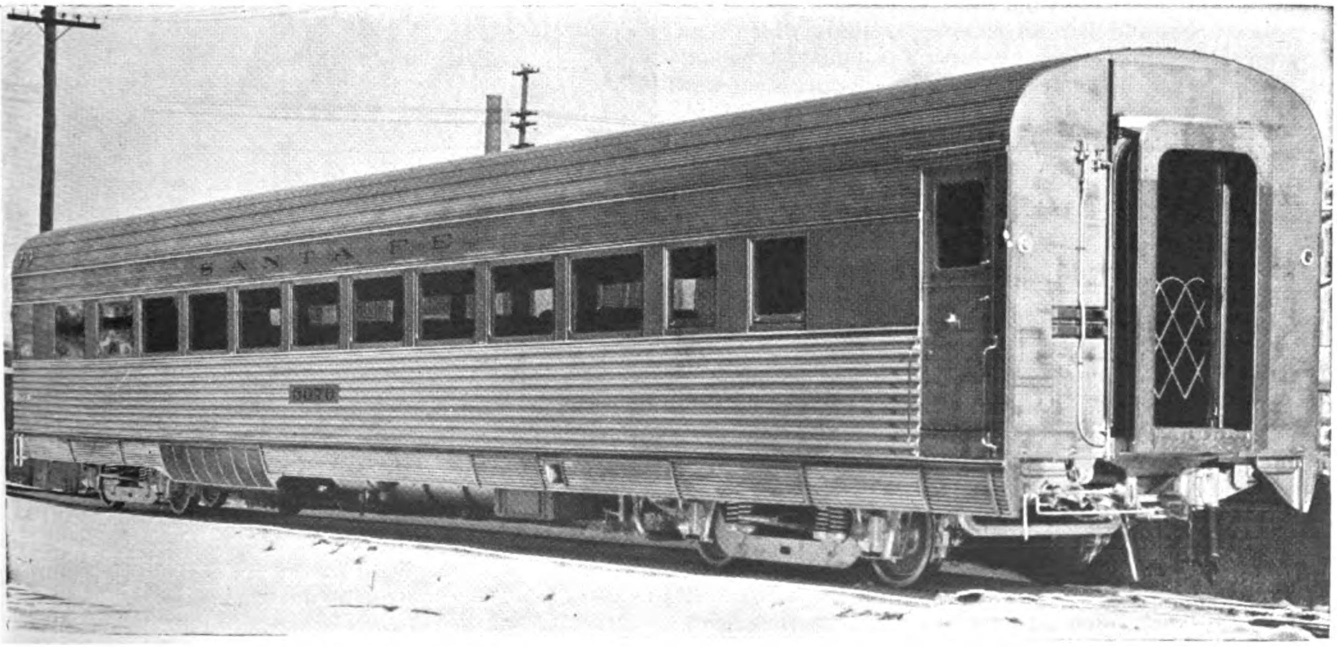
Although of full conventional width and designed for use in long trains of heavy cars, with center sills capable of withstanding more than the maximum required buffing load of 400,000 lb., the light weight of the car, ready for service, is only 83,530 lb., which is about half as much as an ordinary Santa Fe chair car. The car body, completely equipped, weighs on the center plates 52,000 lb., of which 14,000 lb. is accounted for by the stainless steel in the structure. The trucks weigh 28,800 lb. The remainder of the service weight is made up of water and supplies. A comparable conventional Santa Fe passenger car weighs about 160,000 lb. light. This coach will be operated in regular service on the heavy main-line trains of the Santa Fe to develop fully the facts as to the serviceability of a car of this type of construction when used interchangeably with heavy standard equipment.

Over the buffers the car is 79 ft. 8 in. long. Over the side rails the width is 10 ft. 1/8 in., and inside it is 9 ft. 3 1/4 in. The height from the rail to the top of the roof is 13 ft. 6 in. The car has an oval, or turtleback form of roof and the sides end in inwardly curving skirts which extend 13 3/8 in. below the bottom of the underframe cross members. A vestibule is provided at one end of the car only.

While equal in size to an 80-passenger coach, it has seats, spaced on 41 1/2-in. centers, for only 52 passengers. The remaining space is devoted to lounging rooms and toilet facilities comparable to those in Pullman cars. At one end of the car is a spacious smoking room for women with four individual chairs, a dressing table and chair, and a full length mirror. At the other end of the car is the men's lounge which seats six, four on a davenport across one end and two in individual chairs.

The Body Structure

The same general principles of construction previously employed in the light-weight articulated trains built by the Budd Company are followed in the construction of this coach. These are the use of structural members of thin-gage stainless steel formed by rolling or folding to provide sections of the required stiffness and joined by the Shotweld process. The type of sections used in this car, however, show considerable modification from those characteristic of the earlier trains. In the trains the



The Atchison, Topeka & Santa Fe de luxe chair car of stainless steel construction

Interior of the passenger compartment

frame of the structure is made up of flanged box sections fabricated in truss form. The characteristic feature of the Santa Fe design is the replacement of the truss members by open sections of inwardly flanged channel form. Those for the cross members of the underframe are 8½ in. deep and the side posts 10½ in. deep. The use of open sections, reinforced where necessary by tie straps across the open side or by fillers, not only simplifies the construction of the sections themselves, but also facilitates the entire fabrication of the structure.

The underframe structure consists essentially of center sills of top and bottom channel sections which are supported by channel cross bearers and tied together at the sides with corrugated vertical webs between the cross bearers. The center-sill channels are 12 in. wide by 1½ in. deep, with 1½-in. outwardly extending flanges parallel to the web. Each channel is formed in two parallel pieces joined on the longitudinal center line by welding through the vertical center flanges and each is reinforced by two 3-in. channels placed within the main channels and welded through their webs to the web of the main channel.

The cross members, which are spaced 27 in. apart, are 8½ in. in depth by 1½ in. in width and, like the center sills, are of $\frac{1}{16}$-in. stainless steel. The flanges are ell-shaped with the legs which are parallel to the web extending inward toward each other and partially closing the open side of the member. These channels are joined by welding to the webs of the top and bottom center-sill channels and at the ends to the side posts. Five longitudinal floor stringers on each side of the center sill rest upon the top of the cross members and form the support for the corrugated stainless steel floor sheets. These longitudinal members are of channel section, with the outwardly extending flanges on the open side welded to the cross members. Flanges accessible for welding to the floor are provided by strips of suitable width welded to the backs of the channels.

The bottom chord member of the side frame consists of a side sill of zee section attached to the bottoms of the posts and the curved skirt which extends below the underframe. This skirt is a corrugated sheet attached to vertical supports at each cross member.

At the ends of the cars the center sills are attached to Cromansil combined sill and bolster structures of Lukenweld construction.

The center sills are designed to withstand a 400,000-lb. buffing load. Because of the distribution of end-load stresses over the entire underframe and floor structure and into the sides of the car, the structure as a whole is capable of withstanding a materially greater load.

The principal members of the side frame are 10½-in. channels of $\frac{1}{16}$-in. stainless steel similar in form to the cross members of the underframe, except that the width of the section is 3 in. These channels are tied together at the longitudinal rails, one of which is located between the side sheathing and the skirting at the side sill, one between the top of the letter board and the roofing, and two members, one above and one below the windows.

The outside sheathing below the windows is in the longitudinal concave panel form characteristic of this builder. A change has been made, however, in the method of attaching the panels to the frame members. As originally developed these panels were welded together at their internally projecting flanges and the flanges were welded to clips at each side post. This arrangement permitted the sheets to adjust themselves to the deflection of the frame structure without noticeable warping of the exterior surfaces. The method which has since been developed and which is employed on the Santa Fe coach is shown in one of the drawings. The panels are formed with angle flanges, one leg of each flange turning outward, parallel to the car side frame. In assembling the flanges of adjacent panels are overlapped and secured to the faces of the side posts with machine screws. This leaves an opening between the edges of adjacent panels which is $\frac{39}{64}$ in. wide. Under the head of each machine screw is secured a spring clip. Long channel caps formed to slip over the spring clips

Interior of the women's lounge

and be held in position by them are then inserted in the slot-like openings between panels. By removing the plate which encloses the ends of the sheathing panels the caps may be removed by the insertion of a suitable bar at the end and working them out. The caps add a pleasing beaded effect at the joints between the panels.

The surface of the sheathing between the windows is flat, while that above the windows and on the roof is formed in narrow corrugations, except for that portion of the letter board on which the name of the road appears, which is flat.

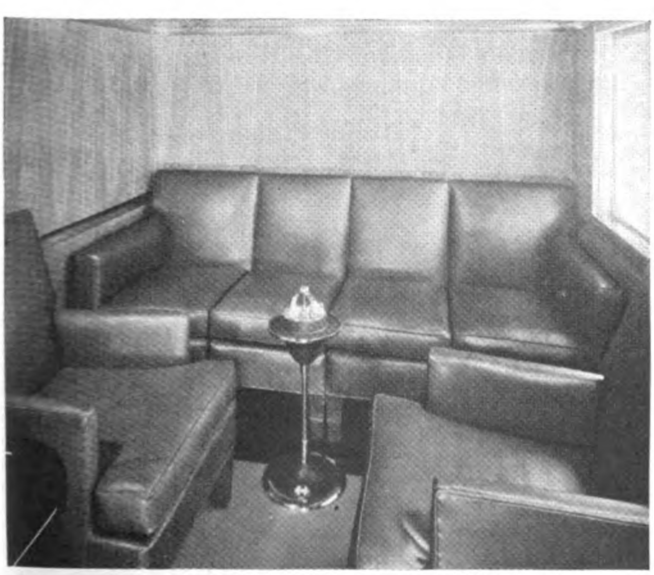
The roof, which serves as a stiff top chord member of the structure, is made up of carlines of channel form with the corrugated roof sheets welded in place on the outside. At the ends of the car a top collision bulkhead is formed by a flat reinforcing sheet applied over the carlines for a distance of 48½ in. back from the end of the car.

End posts built up of stainless steel in deep, relatively heavy sections are securely framed into the underframe at the bottom and into longitudinal members securely attached in the reinforced portion of the roof at the ends. Any load applied directly against these end posts is resisted at the top by the entire roof structure.

The entire car body is insulated with 3-in. Dry-Zero airplane blanket. The sides above and below the windows and the ceilings are finished with Masonite Presdwood which forms the foundation for the Flexwood interior finish. The windows are of double shatterproof glass with nitrogen hermetically sealed between the inner and outer panes to prevent the collection of moisture, resulting in steaming and frosting. All partitions within the car are tied into the body structure and designed to serve as bulkheads.

The floor, which is built up on the corrugated stainless steel sheet covering the entire underframe, consists of cork fillers in the corrugations covered with a 1-in. cork sheet. To the cork surface is attached the linoleum wearing surface. Below the floor is a 3-in. airplane blanket of Dry-Zero held in place by a light stainless steel sheet welded to the under side of the underframe members.

The vestibule is closed by the usual trap door and side door, the latter divided into upper and lower sections. The steps on each side are built as a unit and are hinged to the car by trunions about 5 in. under the top tread. By means of a push rod attached to the



The men's lounge

The hinged steps are opened and closed automatically with the vestibule trap door

under side of the trap door the closing of the latter swings the bottom of the steps up to close the side of the step well. Skirting is so attached to the step structure that with the vestibule closed the surface of the side of the car below the door is unbroken across the step well. The steps remain immovable in their open position so long as the vestibule trap door is open.

Air Conditioning and Heating

The cars are equipped with the Safety-Carrier air-conditioning system and Vapor steam-heating equipment.

The refrigeration unit is placed beneath the car. The condenser air inlet and outlets are in the skirt, the design of these openings being such as to blend with the car construction. The refrigeration unit is fitted with automatic devices which make possible the operation of the equipment through runs where outside temperatures requiring cooling and outside temperatures below freezing are encountered, without servicing enroute.

The air-conditioning unit is mounted over the men's lounge. Complete access for servicing is possible through inspection doors in the ceiling. Conditioned air is delivered to a center duct for distribution through the car.

Outside air is taken in through louvres in the side of the roof and through filters placed vertically in the space between the roof and ceiling. Sufficient filter area for outside air is provided so that all the air circulated through the car may be outside air. A single control operates the dampers at the outside air inlet and the return air grille to give the desired make-up to the air circulated in the car. When the cooling system is in operation the proportion of outside air must be limited to 25 per cent, but when cooling is not required the proportion of outside air may be increased to 100 per cent, resulting in much better car conditions than when the lower content of outside air is maintained under all conditions.

By the selection of light materials and a design which realizes to the fullest extent the saving possible with those materials the weight of the equipment, including a water supply for a ten-hour run, has been decreased 35 per cent from the weight of previous equipment of equal capacity.

The duct for air distribution is located under the center of the roof and above the ceiling. Below the center of the ceiling is an outlet duct running the entire length of the passenger compartment of the car, the under side of which is finished in a stainless steel panel. Grille openings, placed at intervals in the sides of this duct, admit the conditioned air to the car body. The heat exchange equipment is provided with both the cooling and heating elements, the overhead heating being supplemented with the usual floor line radiators. The operation of the heating and air-conditioning equipment is thermostatically controlled through a Vapor control panel.

Lighting

The lighting of the interior of the passenger compartment is provided from two sources. Alternating between the air inlet grilles in the sides of the ceiling duct are placed Transilux fixtures, eight on each side. These provide a semi-indirect lighting, diffused from the ceiling, which may be dimmed for night use. On the under side of the luggage rack over each seat is a Prismatic Lens light which is designed to provide from 7 to 8½ foot candles at the reading plane for seated passengers. These lights are turned off at night.

The lounges are provided with wall Louvelites and Columlites at the lavatories and dressing table. A canopy light is provided for the full-length mirror in the ladies' lounge. Ceiling lights of the Prismatic Lens type are provided in the corridors. The fixtures were furnished by the Safety Car Heating & Lighting Company. Other features of the lighting equipment are the Safety control panel and Exide 850-amp.-hr. battery.

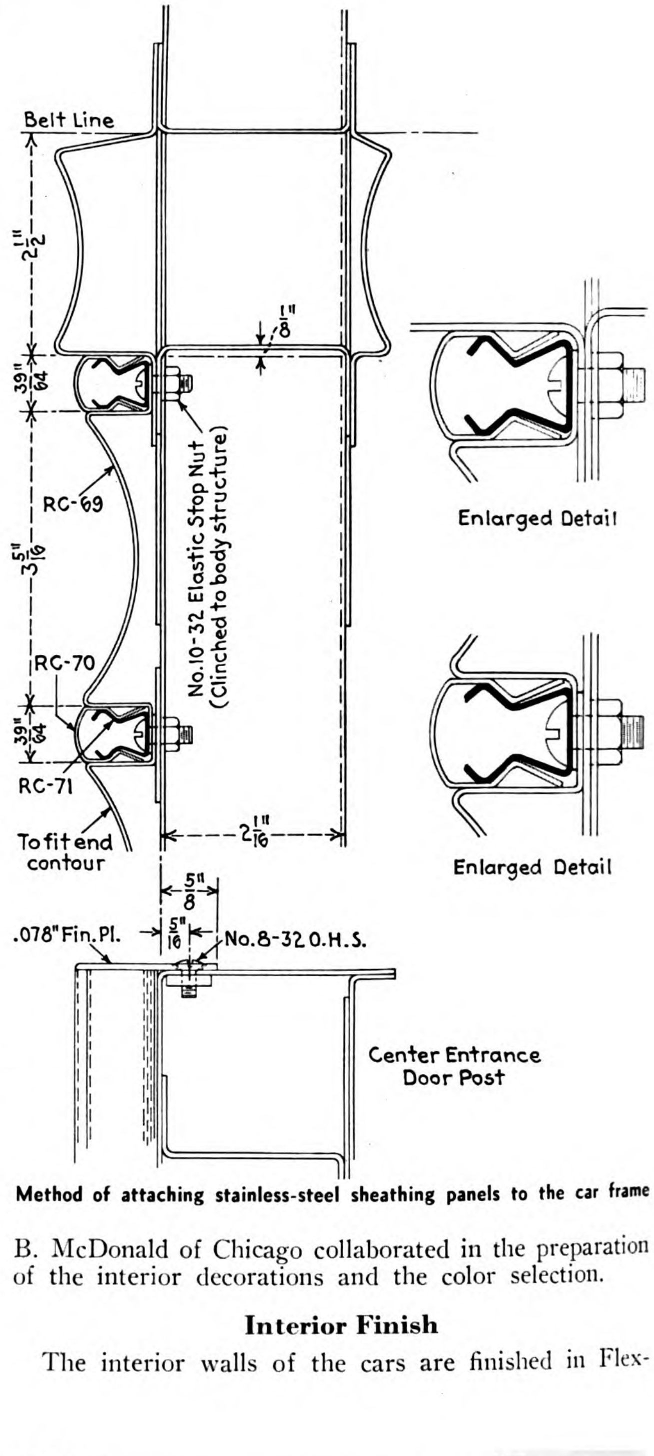
Trucks

The car is carried on four-wheel trucks with 5-in. by 9-in. journals, fitted with Satco bearings. The wheels are two ear, rolled steel, finished with cylindrical treads, 35 in. in diameter. The wheel base of the trucks is 9 ft. and they are spaced 53 ft. between centers.

The truck frames and bolsters are of nickel cast steel and are designed for the usual equalizer type of spring suspension. The bolsters are fitted with lateral hydraulic shock absorbers, and sound insulating inserts of rubber have been applied. The trucks are equipped with the Unit Cylinder type clasp brakes.

The car is equipped with Miner light-weight type draft gears and buffers, and Alliance alloy-steel couplers. The air brakes are Westinghouse UC type.

The design of this car was developed jointly by the engineering staff of the Atchison, Topeka & Sante Fe and the Edward G. Budd Manufacturing Co. Sterling

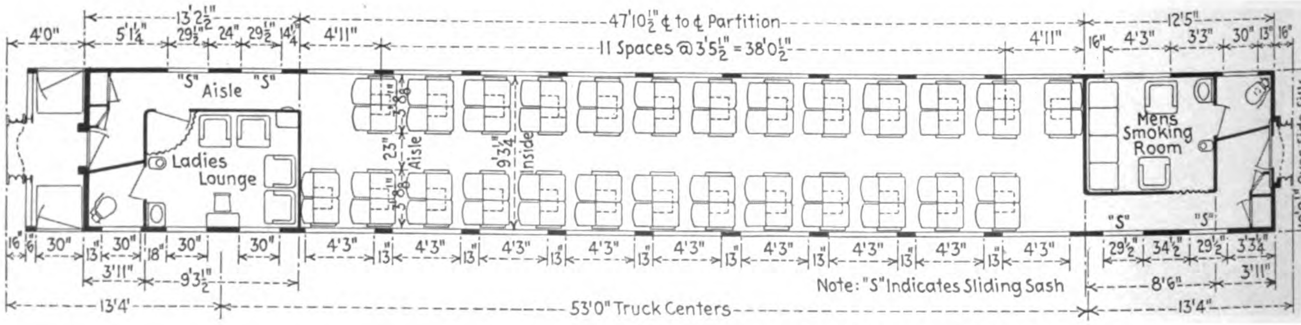


Method of attaching stainless-steel sheathing panels to the car frame

B. McDonald of Chicago collaborated in the preparation of the interior decorations and the color selection.

Interior Finish

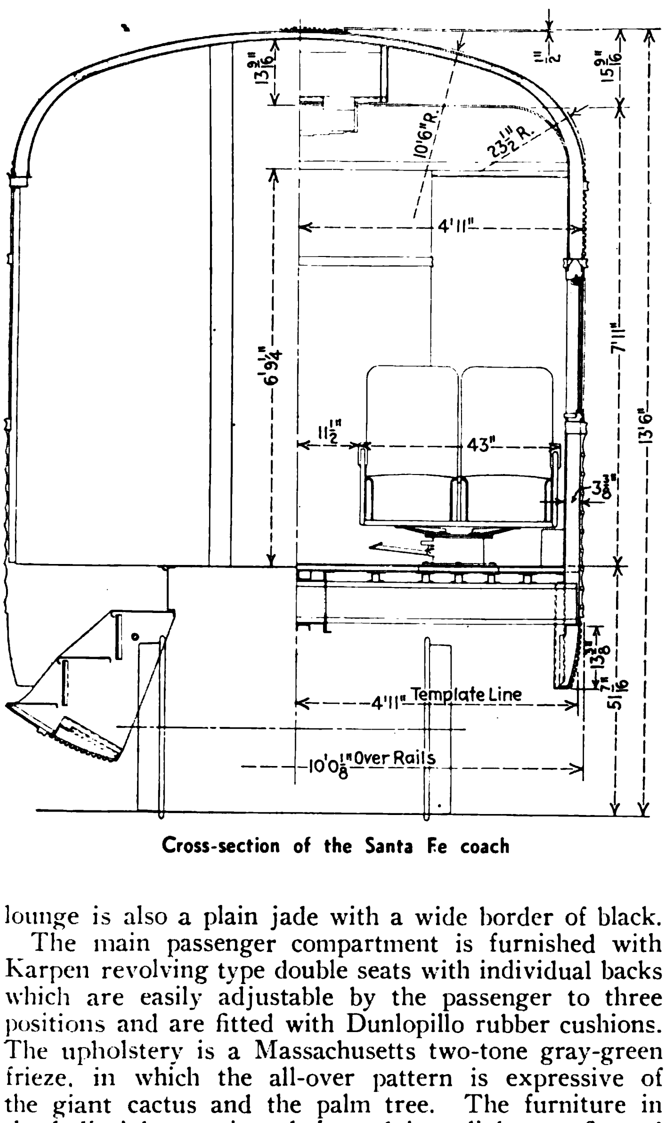
The interior walls of the cars are finished in Flex-



Floor plan of the Santa Fe stainless steel coach

wood veneer on Presdwood or steel. American walnut is used from the floor to the polished stainless-steel window rail, a brown oriental wood in the panels between the windows and on the partitions and prima vera, similar to a light oak, on the under side of the overhead baggage racks. The ceiling of the passenger compartment is finished in a light ivory. The walls of the ladies' lounge are finished in harewood, with a medium gray ceiling. Both walls and ceiling of the men's lounge are finished in quartered oak, with a beam effect on the ceiling.

The floors are finished in linoleum. That in the main passenger compartment is a brown jaspe, with a large diamond pattern in the aisle strip outlined by stripes of yellow and with a black border along the ends of the seats. In the ladies' lounge a plain jade linoleum, with a wide evergreen border, is used. That in the men's lounge is also a plain jade with a wide border of black.



Cross-section of the Santa Fe coach

The main passenger compartment is furnished with Karpen revolving type double seats with individual backs which are easily adjustable by the passenger to three positions and are fitted with Dunlopillo rubber cushions. The upholstery is a Massachusetts two-tone gray-green frieze, in which the all-over pattern is expressive of the giant cactus and the palm tree. The furniture in the ladies' lounge is upholstered in a light tan figured fabric. In the men's lounge the upholstery is maroon leather.

The windows are fitted with roller type shades, the rollers being housed in recesses formed in the longitudinal rail over the tops of the windows. Outside, the shades are finished in aluminum, which accords in color with the stainless steel exterior of the car and acts as a heat-reflecting surface. On the inside the green of the shades harmonizes with the gray-green of the seat upholstery.

What About Mechanics and Supervisors for the Future

*By E. C. Williams**

The average railroad man of today is 40 years of age, or older, and in a few more years will pass on over the hill and out of the picture. Our railroads are giving little thought to the training of the younger generation to take care of this critical situation; only a few young men are serving any kind of apprenticeship in our railroad shops today. In ten short years the average mechanic of today will be retired from service or will have passed away.

Who will step in and carry on? We can't say that the mechanics who have been laid off during the days of depression will be the ones, because Old Father Time will also have them, since they will be past the age limit.

Many will say that the apprentices will step in and carry on, but this is also untrue, since apprentices in railroad shops today are almost as scarce as the buffaloes on the plains.

This matter is far more serious than most of us realize. I sincerely hope that some of the leaders will see how vital it is to the future of our railroads, and will make efforts to correct it now, while there is yet time.

In a few years more the equipment that is now in service will be obsolete and will be replaced with modern designs, and then the railroad officials will realize that we, the mechanics of today, are also obsolete and very much out-of-date and will, of course, be of little use, since we were trained to make repairs to the obsolete equipment and our age will not permit us to learn the trade all over again.

I would like to say for the benefit of the young men who are serving their apprenticeship in various shops throughout the country, that I don't believe anyone has a brighter future before them. If they will only apply themselves and do everything in their power to learn about the modern equipment, these young men will be the leaders of the railroads of tomorrow.

An apprentice working part-time, as has been the custom in the past, will put in approximately six calendar years before his apprenticeship is completed, and he is qualified as a journeyman. Then there is another lapse of three to five years of work and experience that he must go through before he can really render the service he should to the company that employs him.

The point that I am trying to stress is this—if all railroads were filled to capacity with apprentices now, it would be a matter of from eight to ten years before the majority of them would have acquired the knowledge and ability to carry on. Many, many of the older men will be gone on by that time, so the railroads have a very serious situation confronting them. Let us hope it will be corrected before it is too late!

* Boiler Foreman, Kansas City Southern, Shreveport, La.

Railroad, Pennsylvania.—"Railroad, Pennsylvania," is on the Pennsylvania Railroad. It is on a railroad, yet has no railroad station. Shrewsburg, York County, is the station. "Railroad" is a post office. Yet Shrewsburg, which is 1¼ miles from the railroad, named the town of "Railroad." Years ago (Shrewsburg is over 100 years old) the people of this town would say, "I'm going over to the railroad" or "let's go over to the railroad!" Later when a few buildings were erected at the railroad they "dubbed" it "Railroad" and it still carries that name.

Detroit, Toledo & Ironton 2-8-4 type locomotive for main line freight service. Built by the Lima Locomotive Works, Inc.

General Dimensions, Weights and Proportions

Railroad	D. T. & I.
Builder	Lima Loco. Wks.
Type of locomotive	2-8-4
Road numbers	700-703
Number of locomotives	4
Date built	1935
Service	Freight
Dimensions:	
Height to top of stack, ft. and in.	15-4 7/16
Width overall, in.	10-9½
Cylinder centers, ft. and in.	92½
Weights in working order, lb.:	
On drivers	248,600
On front truck	53,900
On trailing truck	109,000
Total engine	411,500
Tender	361,370
Wheel bases, ft. and in.:	
Driving	16-9
Rigid	11-2
Engine, total	39-3
Engine and tender, total	86-1¼
Wheels, diameter outside tires, in.:	
Driving	63
Front truck	33
Trailing truck	33-45
Engine:	
Cylinders, number, diameter and stroke, in.	2-25 × 30
Valve gear type	Walschaert
Valves, piston type, size, in.	14
Maximum travel, in.	8
Steam lap, in.	1 7/16
Exhaust clearance, in.	l. & l.
Lead, in.	3/16
Cutoff in full gear, per cent.	85
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	250
Diameter, first ring, outside, in.	88
Diameter, largest, outside, in.	100
Firebox, length, in.	132⅛
Firebox, width, in.	96¼
Height mud ring to crown sheet, back, in.	65½
Height mud ring to crown sheet, front, in.	94¾
Combustion chamber length, in.	27
Arch tubes, number and diameter, in.	5-3½
Tubes, number and diameter, in.	77-2¼
Flues, number and diameter, in.	202-3½
Length over tube sheets, ft. and in.	18-0
Net gas area through tubes and flues, sq. ft.	10.1
Fuel	Soft coal
Stoker	Standard-MB
Grate type	Firebar
Grate area, sq. ft.	88.3
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	318
Arch tubes	48
Firebox, total	366
Tubes and flues	4,127
Evaporative, total	4,493
Superheating (Type E)	1,795
Combined evap. and superheat.	6,288
Feedwater heater, type	Worthington-5SA
Tender:	
Style or type	Rect. W.B.
Water capacity, U. S. gal.	22,000
Fuel capacity, tons	22
Trucks	6-wheel
Journals, dia. and length, in.	6½ × 12
General data, estimated:	
Rated tractive force, engine, 85 per cent, lb.	63,250
Speed at 1,000 ft. per min. piston speed m.p.h.	37.5
Piston speed at 10 m.p.h., ft. per min.	266.7
R.p.m. at 10 m.p.h.	53.35
Boiler, evap., (with heater) (Cook) lb. per hr.	65,642
Equiv. evap. per sq. ft. evap. h. s. per hr.	14.62
Weight proportions:	
Weight on drivers ÷ weight, engine, per cent.	60.4
Weight on drivers ÷ tractive force	3.92
Weight of engine ÷ evaporation	6.27
Weight of engine ÷ comb. heat surface	66.44
Boiler porportions:	
Firebox h. s. per cent comb. h. s.	5.8
Tube-flue h. s. per cent comb. h. s.	65.6
Superheat, surface per cent comb. h. s.	28.55
Firebox h. s. ÷ grate area	4.15
Tube-flue h. s. ÷ grate area	46.7
Superheat. surface ÷ grate area	20.35
Comb. h. s. ÷ grate area	71.2
Gas area, tubes-flues ÷ grate area	0.104
Evaporation ÷ grate area	744
Tractive force ÷ grate area	716
Tractive force ÷ evaporation	0.96
Tractive force ÷ comb. h. s.	10.05
Tractive force × dia. drivers ÷ comb. h. s.	634

Rolled Frames in

D. T. & I. Locomotives

Lima builds four 2-8-4 type locomotives, weighing 411,500 lb. and having a tractive force of 63,250 lb., which have frames cut from rolled-steel slabs

The Detroit, Toledo & Ironton has received from the Lima Locomotive Works, Inc., four locomotives of the 2-8-4 type, numbered 700 to 703 inclusive, which will be operated on the main line in heavy freight service. These locomotives weigh 411,500 lb. in working order, the distributions being 248,600 lb. on the drivers, 53,900 lb. on the front truck and 109,000 lb. on the trailing truck. The boiler pressure is 250 lb. the two cylinders are 25 in. in diameter with a stroke of 30 in., and the diameter of the driving wheels is 63 in. These proportions give the locomotive a rated tractive force of 63,250 lb.

These locomotives are the first ones with this wheel arrangement to be used on the D. T. & I. The first 2-8-4 type locomotive was built by the Lima Locomotive Works, Inc., in 1925 and up to date there are 302 locomotives of this type in service on ten American and Canadian railroads. In regard to tractive force, grate area and heating surface, the D. T. & I. locomotive rates as one of the smallest of the 2-8-4 type, although several other designs have a lower total weight.

Frames Cut from Steel Slabs

The outstanding feature of these locomotives is the frames. These have been cut out of rolled-steel slabs. The material used is a normalized and tempered carbon steel possessing a high degree of homogenity. This quality and the high physical properties of the material are indicated in one of the tables. The location of each test piece included in this table is indicated on the frame diagram. From this it will be seen that two test pieces were taken out of the metal removed from each pedestal, one taken out near the top and one near the bottom, and one specimen from the metal removed below the front rail of the frame. The maximum variation in yield point is between 40,540 lb. and 45,180 lb., while the maximum variation in ultimate strength is between 71,800 and 79,940 lb. The elongation is confined between 29.5 and 32 per cent and the reduction in area between 53.3 and 56 per cent. The rolled-steel slab frame and its production have been developed by the Lima Locomotive Works, Inc., working with the Carnegie-Illinois Steel Company.

The thickness of the frames is 6 in. and they are spaced on 40 in. centers. The frames are joined together by the usual transverse cast-steel bracing, including rear deck and front bumper castings.

Clearance restrictions limited the height of the stack to 15 ft. 4⁷⁄₁₆ in. above the rail and the width overall to 10 ft. 9½ in.

The boiler carries a steam pressure of 250 lb. The first shell course has an outside diameter of 88 in., the second course is conical, and the third or dome course has an outside diameter of 100 in. The design provides a generous steam space above the water level. The fire-

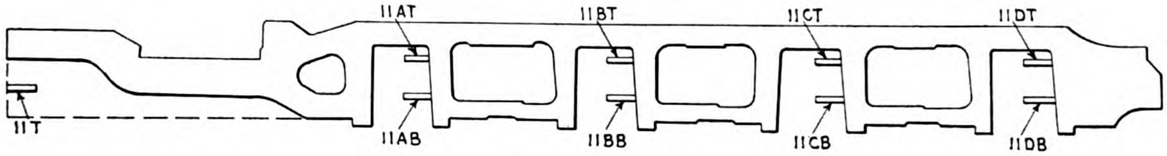
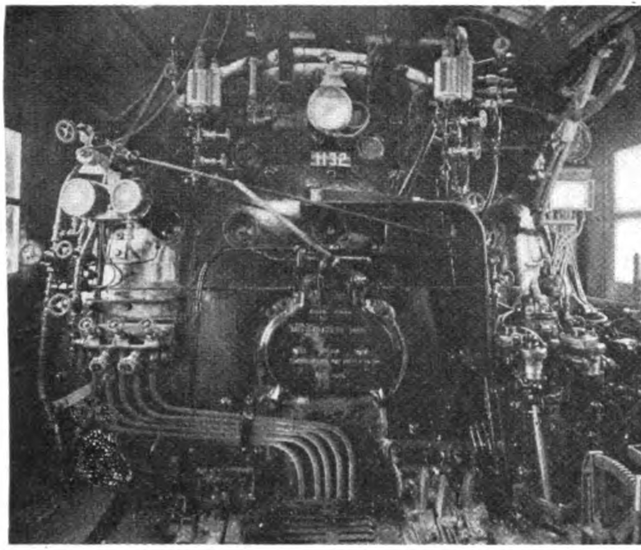


Diagram of the D. T. & I. frame showing location of the test specimens

Tests of Rolled Steel Frames—D. T. & I. 2-8-4 Type Locomotives

Test identification	Yield point, lb. per sq. in.	Ultimate strength, lb. per sq. in.	Elongation, per cent	Reduced dimensions, per cent
11-T	44,640	78,940	30.0	54.7
11-AT	43,130	78,930	31.0	53.3
11-AB	44,180	79,430	29.5	53.3
11-BT	45,180	79,940	32.0	53.3
11-BB	43,730	79,780	30.0	53.3
11-CT	42,990	79,680	30.0	53.3
11-CB	43,980	78,240	31.0	54.7
11-DT	40,540	71,800	29.5	54.7
11-DB	42,230	73,340	31.0	56.0


One of the D. T. & I. frames cut from a slab of rolled steel



Interior view of cab showing back boiler head arrangement

box, 132⅛ in. long and 96¼ in. wide, has a combustion chamber extending 27 in. forward of the throat. The Security brick arch is carried on five 3½-in. arch tubes. The slope of the crownsheet is 6¼ in. and that of the grate 23 in. The shell contains 77 tubes, 2¼ in. in diameter of No. 12 gage, and 202 flues, 3½ in. in diameter of No. 11 gage, the length of the tubes and flues being 18 ft. 0 in. The grates are of the Firebar type and the fuel, soft coal, is fed by a Standard Type MB stoker. The stoker engine is located on the tender in a compartment formed in the left-hand water leg.

The superheater is a Type E, and an American multiple-throttle is incorporated in the superheater header. A Worthington feedwater heater, Type 5SA, is fitted and this is supplemented by a Sellers Class S non-lifting live steam injector.

The two-cylinders, 25 in. in diameter by 30 in. stroke, are of the half-saddle type and spaced 92½ in. between centers. In addition to the usual bolting the cylinders are joined to the frames by welding and the bolted joint between the two cylinder castings is also reinforced by welding. The piston valves, which are actuated by a Walschaert gear, are 14 in. in diameter and have a maximum travel of 8 in. Care was taken to furnish large capacity live and exhaust steam passages. The distributing valves have a steam lap of 1$\frac{7}{16}$ in. and a lead of $\frac{3}{16}$ in. in full gear. No exhaust clearance is provided, the valves and ports being line and line. The reverse gear is an Alco Type G.

Crossheads and guides are of the multiple-bearing type. A Tandem main rod, 125 in. long, connects to the crank pin on the third pair of drivers with an extension to the rear drivers, and side rods connect the first and second pairs of drivers to the main crank pin.

The driving wheel base is 16 ft. 9 in., the 63-in. driving wheels being uniformly spaced 67 in. between axle centers. There is an Alco lateral cushioning device for the driving boxes on the front wheels which permits of a movement of ⅝ in. to each side of the center line and reduces the rigid wheel base to 11 ft. 2 in. The distance between the front truck wheels and the first pair of drivers is 116 in. and from the rear drivers to the front wheels of the trailing truck is 84 in.

The two-wheel front truck is a General Steel Castings constant-resistance design, having outside journals. The four-wheel trailing truck is of the Delta type with a wheel base of 5 ft. 10 in. The front truck wheels are 33 in. in diameter. On the trailing truck the front wheels are 33 in. in diameter; on the back wheels, 45 in. in diameter. While a booster was not applied at the time the engines were built provision was made for a future application should this be desired.

The cab is of the vestibule type and has Lima Comfort cab seats. The brake equipment is New York, schedule 6 ET, with two 8½-in. cross-compound air compressors located on the front deck. A Detroit mechanical lubricator, Model B, provides lubrication to the steam pipes, engine cylinders, front truck bearings, crosshead guides, steam cylinders of the air compressors and the hot-water pump. Other special equipment includes a Nathan low-water alarm and a Franklin radial buffer between the engine and tender. Superheated steam is used for the blower, all other auxiliaries are operated by saturated steam.

The tender is of the rectangular type mounted on a cast-steel water-bottom frame and has a capacity for 22,000 gal. of water and 22 tons of coal. The loaded weight of the tender is 361,370 lb. and the light weight 136,100 lb. It is carried on Buckeye six-wheel trucks with 33-in. wheels and 6½-in. by 12-in. axle journals. The tender trucks have a wheel base of 10 ft. and are spaced on 22 ft. 9 in. truck centers.

Cause of Fire on Santa Fe Diesel Locomotive

A Diesel-electric locomotive, a description of which was given in the *Railway Mechanical Engineer,* December, 1935, was delivered to the Atchison, Topeka & Santa Fe in October, 1935. This locomotive was made up of two identical sections, each of which contained two power units of 900 hp., and provided with an operating cab at each end, control being of the multiple-unit type.

During a westbound test run on November 20 from Chicago to Los Angeles with a special train of eight cars of standard passenger-train equipment, a fire broke out in the engine compartment of the forward unit. Shortly before the accident the train had stopped at Gallup, N.M., to change crews, at which time the forward engine in the front unit had been cut out on account of a scored cylinder. The fire was discovered about seven miles west of the station, at which time the train was running about 70 m.p.h. on a 0.5 per cent descending grade. The train stopped approximately one mile from the point of the application of the brakes. As soon as possible after stopping the first unit of the locomotive was uncoupled, and the train backed away from the burning unit. The fire was ultimately extinguished by the discharge from a blow-off cock of a steam locomotive placed alongside the blazing unit on an adjacent track. No one was seriously injured, but the fire, which was intense while it lasted, did extensive damage to machinery and equipment.

The forward unit was held at Gallup four days for preliminary examination, but no parts were removed or disassembled. The superstructure was then sealed and this unit hauled by the second unit to the shop of the Electro-Motive Corporation, LaGrange, Ill., where a joint detailed examination was made by representatives of the A.T.&S.F., the engine builder and the I.C.C. Bureau of Locomotive Inspection.

The formal report of the Bureau of Locomotive Inspection contains a description of the locomotive, an account of the accident, the examination after the accident, and the results of the final examination. It is from this report that the facts given herewith are taken.

The following brief description of the locomotive and

its equipment will aid in an understanding of what occurred. Each unit, with operating cabs at each end, contains a central engine room separated from the cabs by bulkheads, each having two swinging doors. The engine room contains two 900-hp. Diesel-electric power plants.

Two belt-driven fans for drawing air into the engine room through openings at each end above the operator's cab are located over each power plant. The cooling water radiators are hung from the engine room roof on both sides of and parallel to the exhaust-manifold well, and after passing through the radiators the air flows out through a series of vents into the exhaust manifold well, which forms a trough along the longitudinal center line of the roof.

An auxiliary 90-hp. Diesel engine and heating boiler are located in the center portion of the engine room between the two main power plants. The Diesel engine is direct connected to a generator used for charging the storage batteries, and belt connected to an air compressor and a traction motor blower fan which draws air from the outside and delivers it to the traction motors.

The fuel oil is carried in two 400-gal. tanks connected to a common sump and mounted underneath the bed of the locomotive unit. Filling holes for these tanks are provided in the outer walls to permit filling from the outside and they are equipped with safety plugs designed to prevent flame from entering the tank and to relieve any pressure therein. Each fuel tank is provided with one 1-in. and one 2-in. vent pipe. The 1-in. pipes extend through the bottom of the exhaust-manifold well and terminate in return bends just below the level of the roof. The 2-in. vent pipes extend to approximately the same height and terminate in return bends near the vertical wall of the exhaust-manifold well and inside of the engine room. Any discharge from the 2-in. vent pipes would pass downward through the radiator and into the engine room.

At the time wayside filling stations had not yet been established and each engine unit was temporarily equipped with a rotary refueling pump driven by a chain from the end of the shaft of the air compressor. A jaw clutch, mounted close to the compressor and moved in or out by a lever, permitted the refueling pump to be operated when desired. A pin passing through the lever was provided to hold the clutch disengaged. The inlet pipe to the pump was provided with a gate valve and a connection so that a hose could be passed through a window and coupled to a tank car or wayside tank and oil pumped into the fuel tanks on the locomotive. For the test run a reserve supply of fuel oil was carried in two tanks in a baggage car of the train which were connected to a steel armored hose which extended through the two locomotive units and was connected to the refueling pump in each unit.

The tanks in the baggage car were refilled at Albuquerque, 160 miles east of Gallup, and then contained 3,385 gal. of oil. Refueling of the rear engine unit was completed shortly before reaching Gallup and the tanks on the front unit would then have been refilled had not the operation been delayed by the stop. Upon leaving the station the fireman and the attendant whose duty it was to operate the refueling pumps were called upon to transfer lubricating oil from the rear to the front engine unit. While this work was being performed the fire occurred.

The examination after the fire had been extinguished disclosed the fact that the pin which should have been in the lever operating the clutch driving the refueling pump on the front engine unit was missing and the clutch was partly engaged, also that the gate valve to the pump which should have been closed was more than half open. This permitted the pump to operate and, after the fuel tanks had been filled, the surplus escaped through the vent pipes—part of it dripping onto the engine-room floor and part of it being caught and broken up into a fine spray by the blast from the ventilating fans of the rear power unit which delivered 50,000 cu.ft. of free air per min. at full engine speed. An examination of the track showed that there was oil on the roadway and rails for approximately four miles back from the point where the train stopped, and the condition of the rails indicated that the wheels had been sliding for about three quarters of a mile. It was later found that twenty pairs of wheels on the train were slid flat. This indicated that the refueling pump must have gone into operation soon after the train left Gallup. The wastage was estimated at 350 gallons.

The report closed with the following conclusions:

(1) The direct cause of the accident was improperly located outlets to the vent pipes which discharged the overflow from the fuel-oil tanks into the engine room.

(2) The oil tanks were overflowed, in the absence of an attendant, by oil from a hose line extending from tanks in a baggage car to a refueling pump in the engine room of the unit. Manually operated stop valves in the hose line, at the tanks in the baggage car and at the refueling pump inlet were found in open position. The jaws of the clutch mounted on one end of the air-compressor shaft that drove the refueling pump, which was used for transferring oil through the hose line to the fuel tanks of the unit, were found engaged and the pin provided to hold the clutch handle in off position was not in place. The cause, or causes, for engagement of the clutch and the manually operated stop valve at the inlet of the refueling pump being opened could not be determined. The stop valve at the tanks in the baggage car had been left open by the attendant after completion of refueling of Unit 1-B, as he had anticipated refueling Unit 1-A immediately thereafter, but this operation was interfered with by the stop the train made at Gallup and by being called upon to perform other work when leaving Gallup.

(3) The presence of this refueling arrangement on the unit was a violation of Rule 256 of the Rules and Instructions for Inspection and Testing of Locomotives Other than Steam, which reads: "Fuel reservoirs shall be arranged so they can be filled only from outside of the cab or other compartments."

(4) The fuel oil that was discharged into the engine room from the vicinity of the roof was mixed with air by a strong blast from the cooling and ventilating fans driven from the rear main engine and formed a readily combustible mixture. The exact cause of ignition was not determined, but a number of theories were advanced as to the possible causes, among which are the following: Mixture being blown against the hot exhaust stack of the auxiliary engine, the smokestack of the heating boiler, the hot casting on top of the heating boiler, or drawn through the slotted openings into the boiler fans and thence blown against the red-hot cover of the combustion chamber of the heating boiler; sparking at commutators of heating-boiler motors or auxiliary generator; sparking at storage-battery connections, temporary connection having been made across three front cells by clips and loose wiring which were found on top of the batteries after the fire; sparks from the brake shoes at the time the running test of the brakes was made leaving Gallup.

While there was normally considerable oil scattered on the trucks, piping and fuel tanks, those who participated in the investigation were generally of the opinion that the source of the fire was within the engine room, rather than external.

Passenger Cars Air-Conditioned During 1935*

Railroad	No. of Cars	Type of Cars	Date Equipped	Type of System	Manufacturer of System	Compressor Drive	Refrigerant	Generators: No.	Generators: Capacity Kw.	Generators: Type of Drive	Storage Batteries: Type of Mounting	Storage Batteries: Make	Storage Batteries: Ampere-hour Capacity	Outside Power Supply: a. c. or d. c.	Outside Power Supply: Phase	Outside Power Supply: Cycles	Outside Power Supply: Volts
Alton	5	Cafe-Club	1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Exide, Edison, U. S. L. & K. W.	1,000	d. c.	..	..	32
	2	Pass.-Mail	1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body		1,000	d. c.	..	..	32
A. T. & S. F.	4	Diners	1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-2 1-4	Flat belt	Truck	Exide	640-850	....	..	..	...
	1	Cafe-obs.	1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Truck	Exide	640-850	....	..	..	...
	8	Coach-club	1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-2 1-4	Flat belt	Truck	Exide	640-850	....	..	..	...
	2	Cafe-lounge	1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Truck	Exide	640-850	....	..	..	...
	54	Chair	1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-2 1-4	Flat belt	Truck	Exide	640-850	....	..	..	...
	4	Parlor	1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-2 1-4	Flat belt	Truck	Exide	640-850	....	..	..	...
	4	Parlor-club	1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-2 1-4	Flat belt	Truck	Exide	640-850	....	..	..	...
A. C. L.	12	Coaches	1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Body	Edison	600	....	..	..	...
	3	Coaches	6-1935	Mech.	Safety C. H. & L.	......	Freon	1	20	V-belt-gear	Body	2 Edison, 1 Exide	1,000	....	..	..	...
B. & O.	29	Coaches	1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body	Exide, Gould, Edison, K. W., U. S. L.	1,000	d. c.	..	..	32
	9	Comb.	1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body		1,000	d. c.	..	..	32
	5	Cafe-club	1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body		1,000	d. c.	..	..	32
	4	Club-bagg.	1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body		1,000	d. c.	..	..	32
	7	Cafe-parlor	1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body		1,000	d. c.	..	..	32
	1	Business	1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt-gear	Body		1,000	d. c.	..	..	32
	1	Comb.[1]	1935	Mech.	B. & O.—York	Motor	Freon	1	6	Driven by main engine	......	Exide	600	d. c.	..	..	32
	2	Coach[1]	1935	Mech.	B. & O.—York	Motor	Freon	1	6	Flat belt	Body	Exide	600	d. c.	..	..	32
	5	Coaches[2]	1935	Mech.	B. & O.—York	Motor	Freon	2	6	Flat belt	Body	Edison	1,000	d. c.	..	..	32
	2	Diners[2]	1935	Mech.	B. & O.—York	Motor	Freon	2	6	Flat belt	Body	Edison	1,000	d. c.	..	..	32
	4	Chair[2]	1935	Mech.	B. & O.—York	Motor	Freon	2	6	Flat belt	Body	Edison	1,000	d. c.	..	..	32
	2	Obs.-chair[2]	1935	Mech.	B. & O.—York	Motor	Freon	2	6	Flat belt	Body	Edison	1,000	d. c.	..	..	32
	1	Buffet-lounge[2]	1935	Mech.	B. & O.—York	Motor	Freon	2	6	Flat belt	Body	Edison	1,000	d. c.	..	..	32
B. & M.	3	Coaches[3]	1935	Mech.	Frigidaire	Motor	Freon	1	32	V-belt	Part of Power plant	None	....	....	..	..	...
	10	Coaches	1935	Mech.	G. E.—Sturtevant	Motor	Freon	1	20	Gear	Truck	Exide	500 at 64 v.	....	..	..	...
C. of Ga.	2	Buffet-lge.-coach	6-1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	Flat belt	Body	Edison	600 two sets	....	..	..	...
	2	Lounge-coach	8-1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	Flat belt	Body	Exide	750	....	..	..	...
C. & O.	2	Business	1934	Mech.	P. C. & M. C.	Speed reducer and motor	Freon	2	4	Flat and V-belt	Body	Exide	500	a. c.	3	60	220
	1	Business	4-1935	Mech.	P. S. C. M. C.-Frigidaire	Speed reducer and motor	Freon	2	4	Flat and V-belt	Body	Exide	500	a. c.	3	60	220
	14	Salon-coach	5-1935	Mech.	P. S. C. M. C.-Frigidaire	Speed reducer and motor	Freon	1	4	Flat belt	Body	Exide	350	a. c.	3	60	220
	2	Diners	4-1935	Mech.	P. S. C. M. C.-Frigidaire	Speed reducer and motor	Freon	1	4	Flat belt	Body	Exide	500	a. c.	3	60	220
C. & E. I.	2	Diners	4-1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-5 1-4	Flat belt	Body	Edison	852	....	..	..	...
	1	Cafe-lounge	6-1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-5 1-3	Flat belt	Body	U. S. L.	1,000	....	..	..	...
	1	Cafe-lounge	6-1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Body	Gould	850	....	..	..	...
C. M. St. P. & P.	4	Diners	1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt	Truck	Exide	850	d. c.	..	..	32
	14	Tour.-sleepers	1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt	Truck	Exide	850	d. c.	..	..	32
	6	Parlor	1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt	Truck	Exide	850	d. c.	..	..	32
	2	Cafe[4]	1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt	Truck	Exide	850	d. c.	..	..	32
	4	Parlor[4]	1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt	Truck	Exide	850	d. c.	..	..	32
	38	Coaches[4]	1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt	Truck	Exide	850	d. c.	..	..	32

*This tabulation includes cars placed in service during 1934 which were not reported in table published in December, 1934 *Railway Mechanical Engineer*.

Passenger Cars Air-Conditioned During 1935 (Continued)

Railroad	No. of Cars	Type of Cars	Date Equipped	Type of System	Manufacturer of System	Compressor Drive	Refrigerant	Generators: No.	Capacity Kw.	Type of Drive	Type of Mounting	Storage Batteries: Make	Ampere-hour Capacity	Outside Power Supply: a. c. or d. c.	Phase	Cycles	Volts
C. B. & Q.	2	Chair	6-1935	Ice	C. B. & Q.-Trane	...	Ice	1	5	Gear	Body	...	500	...	..	..	...
	16	Chair	6-1935	Mech.	Trane	Motor	Freon	1	20	V-belt-gear	Body	...	1,000	a. c.	3	60	220
	10	Chair	6-1935	Ice	C. B. & Q.-Trane	...	Ice	1	3 or 4	Flat belt	Body	...	500	...	..	..	...
	10	Diners	6-1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt	Truck	...	1,000	a. c.	3	60	220
	2	Coaches	6-1935	Mech.	Frigidaire	Motor	Freon	2	1-15	V-belt-gear	Body	...	1,000	a. c.	3	60	220
									1-4	Flat belt							
	3	Coaches	6-1935	Ice	C. B. & Q.-Trane	...	Ice	1	3 or 4	Flat belt	Body	...	500	...	..	..	...
	4	Coaches	6-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4 or 5	Flat belt	Body	...	500	a. c.	3	60	220
	2	Coaches	6-1935	Ice	C. B. & Q.-Trane	...	Ice	1	4	Flat belt	Body	...	500	...	..	..	...
	2	Coaches	6-1935	Mech.	Frigidaire	Motor	Freon	1	15	Gear	Body	...	1,000	a. c.	3	60	220
	6	Coaches	6-1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt-gear	Body	...	1,000	a. c.	3	60	220
	1	Coach[5]	1935	Mech.	York	Motor	Freon	1	15	V-belt	Body	...	...	a. c.	3	60	220
	2	Coaches[6]	1935	Mech.	General Electric	Motor	Freon	1[6]	32	V-belt from main engine	...	...	450 at 64 v.	a. c.	3	60	220
	2	Lounge[6]	1935	Mech.	General Electric	Motor	Freon	1[6]	32		...	...	450 at 64 v.	a. c.	3	60	220
	1	Coach[6]	10-1935	Mech.	Frigidaire	Motor	Freon	1[6]	32		...	...	450 at 64 v.	a. c.	3	60	220
	1	Lounge[6]	10-1935	Mech.	Frigidaire	Motor	Freon	1[6]	32		...	...	450 at 64 v.	a. c.	3	60	220
C. & N. W.	11	Coaches	1935	Mech.	Waukesha	Motor	Methyl-chloride	1	15	V-belt-gear	Body	Edison	800	...	..	..	...
	1	Coach	6-1935	Mech.	R. R. Co.	Gas-engine	Freon	..	...	...	...	...	...	...	..	..	...
	1	Cafe-lounge	5-1935	Mech.	Waukesha	Motor	Methyl-chloride	1	15	V-belt-gear	Body	Edison	800	...	..	..	...
	2	Coaches	4-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	10	Comb.	1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	2	Lounge-coach	5-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	6	Coaches	4-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	26	Coaches	6-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	1	Parlor	5-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	2	Parlor-obs.	5-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	8	Parlor	5-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
C. St. P. M. & O.		Cafe-lounge	4-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	5	Diners	5-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	2	Cafe-lounge	4-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	2	Lounge-coaches	1-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
	2	Coaches	5-1935	Ice	R. R. Co.	...	Ice	..	...	...	...	...	...	...	..	..	...
C. R. I. & P.	8	Chair	6-1935	Ice	A. C. & F.	...	Ice	1	16-2.6 11-4.0	Flat belt	Body	...	450	...	..	..	...
	7	Parlor	6-1935	Ice	A. C. & F.	...	Ice	1			Body	...	450	...	..	..	...
	6	Cafe-lounge	6-1935	Ice	A. C. & F.	...	Ice	1			Body	...	450	...	..	..	...
	6	Diners	6-1935	Ice	A. C. & F.	...	Ice	1			Body	...	450	...	..	..	...
D. & H.	1	Parlor-cafe	6-1935	Ice	Airtrol-Rails Co.	...	Ice	..	...	...	...	Exide	400	...	..	..	...
D. L. & W.	1	Business	1-1934	Ice	Pullman	...	Ice	1	4	Flat belt	Body	Lead	500	...	..	..	...
	10	Coaches	6-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	3	Flat belt	Body	Lead	300	a. c.	3	60	220
	1	Buffet-lounge	8-1935	Ice	Safety C. H. & L.	...	Ice	1	4	Flat belt	Body	Lead	300	...	..	..	...
D. & R. G. W.	16	Coaches	5-1935	Ice	Trane Co.	...	Ice	1	3.5	Flat belt	Truck	Edison	340	...	..	..	...
	4	Diner-lounge	5-1935	Ice	Trane Co.	...	Ice	1	4	Flat belt	Body	Edison	520	...	..	..	...
Erie	1	Parlor-coach	7-1935	St. ejec.	Safety C. H. & L.	...	Water	2	4	Flat belt	Body	Edison	675	...	..	..	...
F. E. C.	3	Diners	7-1935	St. ejec.	Safety C. H. & L.	...	Water	2	3 and 5	Flat belt	Body	Edison	750	...	..	..	...
	8	Coaches	7-1935	St. ejec.	Safety C. H. & L.	...	Water	2	3 and 4	Flat belt	Body	Edison	600	...	..	..	...
Ft. W. & D. C.	6	Coaches	5-1935	Mech.	Frigidaire	Motor	Freon	2	1-15	V-belt-gear	Body	Lead	1,000	a.		60	220
									1-4	Flat belt	Body						
	1	Diner	5-1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt	Truck	Lead	1,000			60	220
	4	Coaches	5-1935	Mech.	Frigidaire	Motor	Freon	2	1-15	V-belt-gear	Body	Lead	1,000	a.		60	220
									1-4	Flat belt	Body						
	3	Diners	5-1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt	Truck	Lead	1,000	a. c.		60	220
Great Northern	12	Coaches	5-1935	Ice	R. R. Co.	...	Ice	1	4	V-belt	Body	Exide	600	...	..	..	...
	4	Diners	7-1935	Ice	R. R. Co.	...	Ice	1	4	V-belt	Body	Exide	600	...	..	..	...
G. M. & N.	1	Coach[7]	7-1935	Mech.	A. C. F.-York	Motor	Freon	1[7]	80	Driven from main engine	...	...	69	a. c.	3	60	220
	2	Sleeper-obs.[7]	7-1935	Mech.	A. C. F.-York	Motor	Freon	1[7]	80		...	...	69	a. c.	3	60	220
	2	Buffet-coach[7]	7-1935	Mech.	A. C. F.-York	Motor	Freon	1[7]	80		...	...	...	a. c.	3	60	220

Passenger Cars Air-Conditioned During 1935 (Continued)

Railroad	No. of Cars	Type of Cars	Date Equipped	Type of System	Manufacturer of System	Compressor Drive	Refrigerant	Generator No.	Generator Capacity Kw.	Generator Type of Drive	Generator Type of Mounting	Storage Batteries Make	Storage Batteries Ampere-hour Capacity	Outside Power Supply a.c. or d. c.	Outside Power Supply Phase	Outside Power Supply Cycles	Outside Power Supply Volts
Ill. Cent.	1	Business	1934	Ice	A. C. & F.	......	Ice	..	....	....	......	Edison	900	....	..	..	...
	2	Comb.	1935	Ice	A. C. & F.	......	Ice	..	....	....	......	Edison	450	....	..	..	...
	3	Cafe-lounge	1935	Ice	A. C. & F.	......	Ice	..	....	....	......	2 Lead 1 Edison	800 600	....	..	..	...
	2	Cafe-coaches	1935	Ice	A. C. & F.	......	Ice	..	....	....	......	Lead	770	....	..	..	...
	2	Buffet-lounge	1935	Ice	A. C. & F.	......	Ice	..	....	....	......	Edison	750	....	..	..	...
	1	Cafe-lounge	12-1935	Mech.	Waukesha	Gas-engine	Freon	..	....	....	......	Edison	375	....	..	..	...
	5	Comb.		Mech.		Speed reducer	Freon	..	....	....	......	1 Edison 2 Edison 2 Lead	450 375 400	a. c.	3	60	220
	2	Coaches	24-1934	Mech.	24-P. C. & M. C.	Speed-reducer	Freon	..	....	....	......	Lead	400	a. c.	3	60	220
	2	Parlor	9-1935	Mech.	9-P. S. C. M. C.	Speed-reducer	Freon	..	....	....	......	Lead	800	a. c.	3	60	220
	6	Buffet-lounge		Mech.		Speed-reducer	Freon	..	....	....	......	Lead	800	a. c.	3	60	220
	18	Diners		Mech.		Speed-reducer	Freon	..	....	....	......	3 Edison 1 Edison 12 Lead 2 Lead	375 450 800 1,000	a. c.	3	60	220
Lehigh Val.	3	Club	8-1934	Mech.	York	Motor	Freon	2	1-10 1-5	Flat belt	Body	Exide	1,000	a. c.	3	60	220
	3	Diners	7-1934	Mech.	A. C. & F.	Motor	Freon	2	1-10 1-5	V-belt-gear	Body	Exide	1,000	a. c.	3	60	220
	1	Club-diner	8-1934	Mech.	General Electric	Motor	Freon	1	20	Gear	Truck	Exide	1,000	a. c.	3	60	220
	1	Club-diner	9-1934	Mech.	Westinghouse	Motor	Freon	1	15	Gear	Truck	Exide	1,000	a. c.	3	60	220
	4	Coaches	6-1935	Mech.	Frigidaire	Motor	Freon	1	15	2-V-belt-gear 2-Gear	Body	Exide	1,175	a. c.	3	60	220
L. & N.	5	Diners	6-1935	St. ejec.	Safety C. H. & L.	......	Water	1	7.5	Flat belt	Body	Exide	850	....	..	..	...
M.-K.-T.	2	Diners	7-1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-4 1-5	Flat belt	Body	U. S. L.	1,000	....	..	..	...
	3	Chair	7-1935	Ice	R. R. Co.	......	Ice	2	3	Flat belt	Body	Edison	600	....	..	..	...
Mo. Pac.	9	Lounge-diners	1934	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	375	....	..	..	...
	1	Lounge-diner	1934	Mech.	West.-Frigidaire	Motor	Freon	1	20	V-belt-gear	Body	Edison	950	a. c.	3	60	220
	7	Lounge-diner	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	375	....	..	..	...
	16	Chair	6-1935	Ice	R. R. Co.	......	Ice	1	6-4 10-3	Flat belt	Body	Edison	7-600 9-375	....	..	..	...
	45	Coaches	6-1935	Ice	R. R. Co.	......	Ice	1	24-4 21-3	Flat belt	Body	Edison	11-600 34-375	....	..	..	...
	8	Comb.	4-1935	Ice	R. R. Co.	......	Ice	1	3	Flat belt	Body	Edison	375	....	..	..	...
	1	Business	7-1935	Ice	R. R. Co.	......	Ice	2	4	Flat belt	Body	Edison	900	....	..	..	...
	7	Coaches	6-1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Body	Edison	750	....	..	..	...
	5	Chair	6-1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Body	Edison	750	....	..	..	...
	4	Diners	6-1934	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt-gear	Body	Edison	600	....	..	..	...
	5	Lounge-diners	1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Body	Edison	750	....	..	..	...
	3	Lounge-diners	6-1935	Mech.	Frigidaire	Motor	Freon	1	20	V-belt-gear	Body	Edison	950	a. c.	3	60	220
N. Y. C. System	1	Coach	9-1934	Mech.	General Electric	Motor	Freon	1	20	Gear	Truck	U. S. L.	450 at 64 v.	....	..	..	...
	46	Coaches	5-1935	Mech.	Frigidaire	Motor	Freon	1	20	Gear	Truck	Exide, Gould, K. W. and U. S. L.	600 at 64 v.	....	..	..	...
	11	Diners	6-1935	Mech.	Airtemp.	Motor	Freon	1	20	Gear	Truck	Exide	600 at 64 v.	....	..	..	...
N. Y. C. & St. L. (NKP)	2	Coaches	9-1934	Mech.	P. C. & M. C.	Speed reducer	Freon	1	4	V-belt	Body	Exide	286	a. c.	3	60	220
	1	Coach	5-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	V-belt	Body	Exide	286	a. c.	3	60	220
N. Y. N. H. & H.	1	Club	8-1934	Ice	R. R. Co.-Rails Co.	......	Ice	..	....	....	......	Exide	300	....	..	..	...
	4	Smokers	7-1934	Mech.	Safety C. H. & L.	Motor	Freon	1	15	V-belt-gear	Body	Exide	1,000	....	..	..	...
	20	Coaches	6-1934	Mech.	Safety C. H. & L.	Motor	Freon	1	15	V-belt-gear	Body	Exide	1,000	....	..	..	...
	3	Comb.	7-1934	Mech.	Safety C. H. & L.	Motor	Freon	1	15	V-belt-gear	Body	Exide	1,000	....	..	..	...
	4	Diners	6-1934	Ice	R. R. Co.-Sturtevant	......	Ice	..	....	....	......	Exide	600	....	..	..	...
	50	L.-w. Coaches	1-1935	Mech.	G. E.-Sturtevant	Motor	Freon	1	20	Gear	Truck	40 Exide 5 Willard	500 at 64 v.	....	..	..	...
	3	Coaches[8]	5-1935	Mech.	Westinghouse	Motor	Freon	2[8]	....	Driven by main engine	......	Exide	110 volts	....	..	..	...
	35	Coaches	6-1935	Ice	R. R. Co.-Sturtevant	......	Ice	..	....	....	......	Exide	432	....	..	..	...
	1	Club	7-1935	Ice	R. R. Co.-Sturtevant	......	Ice	..	....	....	......	Exide	300	....	..	..	...
	10	Smokers	7-1935	Mech.	Safety C. H. & L.	Motor	Freon	1	15	V-belt-gear	Body	Exide	1,000	....	..	..	...
	10	Coaches	7-1935	Ice	R. R. Co.-Sturtevant	......	Ice	..	....	....	......	Exide	432	....	..	..	...
	2	Diners	7-1935	Ice	R. R. Co.-Sturtevant	......	Ice	..	....	....	......	Exide	432	....	..	..	...
	3	Comb.	7-1935	Ice	R. R. Co.-Safety C. H & L.	......	Ice	..	....	....	......	Exide	432	....	..	..	...

Passenger Cars Air-Conditioned During 1935 (Continued)

Railroad	No. of Cars	Type of Cars	Date Equipped	Type of System	Manufacturer of System	Compressor Drive	Refrigerant	Generators: No	Generators: Capacity Kw.	Generators: Type of Drive	Generators: Type of Mounting	Storage Batteries: Make	Storage Batteries: Ampere-hour Capacity	Outside Power Supply: a. c. or d. c.	Outside Power Supply: Phase	Outside Power Supply: Cycles	Outside Power Supply: Volts
Nor. & Wn.	4	Coaches	1-1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	Flat belt	Body	Edison	225 at 110 v.	....	..	..	...
	8	Comb.	2-1935	Mech.	West.-Sturtevant	Motor	Freon	1	15	V-belt-gear	Body	Edison	300 at 110 v.	a. c.	3	60	220
	6	Coaches	5-1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt-gear	Body	Exide	300 at 110 v.	a. c.	3	60	220
	12	Coaches	5-1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt-gear	Body	Edison	300 at 110 v.	a. c.	3	60	220
	1	Diner	5-1935	Mech.	Frigidaire	Motor	Freon	1	15	Gear	Body	Edison	300 at 110 v.	a. c.	3	60	220
	3	Diners	5-1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt-gear	Body	Edison	300 at 110 v.	a. c.	3	60	220
Nor. Pac.	6	Diners	6-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	200	a. c.	3	60	220
	4	Obs.	6-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Gould	600	a. c.	3	60	220
	2	Coaches	6-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Exide	350	a. c.	3	60	220
	10	Coaches	6-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	4	Flat belt	Body	5 Exide 5 Gould	500	a. c.	3	60	220
	4	Coaches	6-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	5	Flat belt	Body	3 Gould 1 Exide	500	a. c.	3	60	220
Pennsylvania	44	Coaches	1935	Ice	R. R. Co.	......	Ice	1	4.8	Flat belt	Body	......	500	....	..	..	...
	6	Comb.	1935	Ice	R. R. Co.	......	Ice	1	4.8	Flat belt	Body	......	500	....	..	..	...
	20	Comb.	1935	Ice	R. R. Co.	......	Ice	1	4.8	Flat belt	Body	......	500	....	..	..	...
	2	M. U. coaches	1935	Mech.	General Electric	Motor	Freon	..	....	....	......	......	....	a. c.	3	60	220
	1	M. U. coach	1935	Mech.	Frigidaire	Motor	Freon	..	....	....	......	......	....	a. c.	3	60	220
	3	Diners	1935	Mech.	Airtemp.	Motor	Freon	1	15	V-belt-gear	Body	......	800	....	..	..	...
	2	Diners	1935	Mech.	Safety C. H. & L.	Motor	Freon	1	15	V-belt-gear	Body	......	800	....	..	..	...
	11	Diners	1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt-gear	Body	......	800	....	..	..	...
	3	Lounge-diners	1935	Mech.	Frigidaire	Motor	Freon	1	15	V-belt-gear	Body	......	800	....	..	..	...
	1	Coach	1935	Mech.	Baldwin-Southwark	Motor	Freon	1	20	V-belt-gear	Body	......	800	....	..	..	...
Pullman	8	Parlor and parlor obs.		Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt and gear	Body	Exide, Gould, K. W. and U. S. L.	1,000	....	..	..	...
	56	Composite		Ice	Pullman	......	Ice	1	4	V-belt	Body	Exide	600	....	..	..	...
	139	Composite		Mech.	P. S. C. M. C.	Motor	Freon	2	1-4 1-15	V-belt V-belt and gear	Body	Exide	1,000	....	..	..	...
	13	Composite	1934 and 1935	Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	Flat belt Flat belt and gear	Body	Exide, Gould, K. W. and U. S. L.	1,000	....	..	..	...
	54	Composite		St. ejec.	Safety C. H. & L.	......	Water	2	4	V-belt	Body	Exide	850	....	..	..	...
	377	Sleepers		Ice	Pullman	......	Ice	1	4	V-belt	Body	Exide	600	....	..	..	...
	882	Sleepers		Mech.	P. S. C. M. C.	Speed-reducer	Freon	1	4	V-belt	Body	Exide	1,000	....	..	..	...
	200	Sleepers		St. ejec.	Safety C. H. & L.	......	Water	2	4	V-belt	Body	Exide	850	....	..	..	...
	99	Sleepers		Mech.	B. & O.—York	Motor	Freon	2	1-4 1-7½	V-belt V-belt and gear	Body	Exide, Gould, K. W. and U. S. L.	1,000	....	..	..	...
Reading	12	Coaches	1935	Mech.	York	Motor	Freon	2	1-4 1-7½	Flat belt	Body	8 Exide 4 Edison	1,000	a. c.	3	60	220
	5	Comb.	1935	Mech.	York	Motor	Freon	2	1-4 1-7½	Flat belt	Body	Exide	1,000	a. c.	3	60	220
	4	Cafe	1935	Mech.	York	Motor	Freon	2	1-4 1-7½	Flat belt	Body	Exide	1,000	a. c.	3	60	220
C. R. R. of N. J.	7	Coaches	1935	Mech.	York	Motor	Freon	2	1-3 1-7½	Flat belt	Truck	4 Exide 3 U. S. L.	1,000	a. c.	3	60	220
	2	Club-coaches	1935	Mech.	York	Motor	Freon	1	3	Flat belt	Truck	Exide	300	a. c.	3	60	220
	1	Club-coach	1935	Mech.	York	Motor	Freon	..	....	....	......	Exide	300	a. c.	3	60	220
	3	Cafe	1935	Mech.	York	Motor	Freon	2	1-4 1-7½	Flat belt	Body	1 Exide 2 U. S. L.	1,000	a. c.	3	60	220
R. F. & P.	2	Comb.	1935	Mech.	Frigidaire-Safety C. H. & L.	Motor	Freon	1	10	V-belt-gear	Body	Edison	300	a. c.	3	60	220
	3	Coaches	1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	3	Flat belt	Body	Edison	300	a. c.	3	60	220
	3	Coaches	1935	Mech.	Safety C. H. & L.	Motor	Freon	1	20	V-belt-gear	Body	2 Edison 1 Exide	1,000	....	..	..	...
	2	Coaches	1935	Mech.	Frigidaire-Safety C. H. & L.	Motor	Freon	1	20	V-belt-gear	Body	Edison	300	a. c.	3	60	220
St. L.-S. F.	2	Diners	1935	Ice	R. R. Co.	......	Ice	1	4	V-belt	Body	Exide	450	....	..	..	...
	4	Chair	1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Exide	450	....	..	..	...
	8	Chair	1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	U. S. L., Gould, Exide	450 or 500	....	..	..	...
	15	Coaches	1935	Ice	R. R. Co.	......	Ice	1	3 or 4	Flat belt	Body	Exide, K. W., U. S. L.	450 or 500	....	..	..	...
	5	Diners	1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	U. S. L., Exide	450 or 500	....	..	..	...
	2	Coach-sleepers	1935	Ice	R. R. Co.	......	Ice	2	1-3 1-4	Flat belt	Body	Exide	900	....	..	..	...
	2	Comb.	1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Exide	450	....	..	..	...
	2	Business	1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Exide	900	a. c.[9]	3	60	220

Passenger Cars Air-Conditioned During 1935 (Continued)

Railroad	No. of Cars	Type of Cars	Date Equipped	Type of System	Manufacturer of System	Compressor Drive	Refrigerant	Generators No.	Generators Capacity Kw.	Generators Type of Drive	Generators Type of Mounting	Storage Batteries Make	Storage Batteries Ampere-hour Capacity	Outside Power Supply a. c or d. c.	Outside Power Supply Phase	Outside Power Supply Cycles	Outside Power Supply Volts
Seaboard Air Line	10	Coaches	10-1934	Mech.	P. C. & M. C.	Speed reducer	Freon	1	3	Flat belt	Body	Edison	300	a. c.	3	60	220
	8	Comb.	10-1934	Mech.	P. C. & M. C.	Speed reducer	Freon	1	3	Flat belt	Body	Edison	300	a. c.	3	60	220
	6	Diners	10-1934	Mech.	P. C. & M. C.	Speed reducer	Freon	1	4	Flat belt	Body	Edison	375	a. c.	3	60	220
	4	Coaches	6-1935	Mech.	P. S. C. M. C.	Speed reducer	Freon	1	3	Flat belt	Body	Edison	300	a. c.	3	60	220
	1	Coach	6-1935	Mech.[10]	P. S. C. M. C.	Speed reducer	Freon	1	3	Flat belt	Body	Edison	....	a. c.	3	60	220
	1	Business	7-1935	Mech.	Waukesha-Melcher	Motor	Freon	1	10	V-belt and gear	Body	Edison	900	....	..	..	...
	3	Rail Cars	12-1935	Mech.	A. C. F.	Gas-engine	Freon	..	....	....	......	Exide[11]	....	....	..	..	...
Southern	27	Diners	1935	St. ejec.	Safety C. H. & L.	......	Water	1	7½	Flat belt	Body	Exide	600	....	..	..	...
Southern Pac.	2	Parlor	6-1934	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	600	....	..	..	...
	4	Lounge-obs.	6-1934	Ice	R. R. Co.	......	Ice	1	5	V-belt	Truck	Edison	750	....	..	..	...
	5	Diners	1934	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	450	....	..	..	...
	5	Parlor	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	600	....	..	..	...
	21	Diners	6-1935	Ice	R. R. Co.	......	Ice	1	4	F at belt	Body	Edison	450	....	..	..	...
	1	Club	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	375	....	..	..	...
	35	Coaches	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	14-600 8-375 13-300				
	21	Chair	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	12-600 6-375 3-300	....	..	..	...
	4	Cafe-Parlor	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	450				
	8	Chair	7-1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-3 1-5	Flat belt V-belt	Body Truck	Edison	900	....	..	..	...
Texas & Pac.	12	Coaches	1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt	Body	Edison	750	....	..	..	...
	10	Coaches	1935	St. ejec.	Safety C. H. & L.	......	Water	1	10	V-belt	Body	Edison	900	....	..	..	...
	1	Diner	1935	Mech.	P. S. C. M. C.	Speed-reducer	Freon	1	.4	Flat belt	Body	Edison	750	a. c.	3	60	220
	1	Business	1935	Mech.	Westinghouse	Motor	Freon	1	15	V-belt	Body	Edison	1,800	a. c.	3	60	220
	4	Chair	1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	375	....	..	..	...
	12	Coaches	1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	450	....	..	..	...
	4	Diners	1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	600	....	..	..	...
Union Pacific	21	Chair	5-1935	Mech.	P. S. C. M. C.	Speed-reducer	Freon	1	4	Flat belt	Body	Edison	300	a. c.	3	60	220
	40	Coaches	5-1935	Mech.	P. S. C. M. C.	Speed-reducer	Freon	1	4	Flat belt	Body	Edison	300	a. c.	3	60	220
	13	Observation	5-1935	Mech.	P. S. C. M. C.	Speed-reducer	Freon	1	4	Flat belt	Body	Exide	500	a. c.	3	60	220
	17	Diners	5-1935	Mech.	P. S. C. M. ..	Speed-reducer	Freon	1	4	Flat belt	Body	Exide	500	a. c.	3	60	220
	5	Coaches	5-1935	Mech.	York	Motor	Freon	2	1-15 1-4	V-belt Flat belt	Body	Exide	1,000	a. c.	3	60	220
	10	Coaches	5-1935	Mech.	Gen'l Electric	Motor	Freon	1	20	Flat belt	Body	Exide	1,000	a. c.	3	60	220
	8	Coaches	5-1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Body	Exide	1,000	....	..	..	...
	17	Chair	5-1935	St. ejec.	Safety C. H. & L.	......	Water	2	4	Flat belt	Body	Exide	1,000	....	..	..	...
Wabash	12	Chair	6-1935	Ice	R. R. Co.	......	Ice	1	3	Flat belt	Body	......	500	....	..	..	...
	2	Cafe-Parlor	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	......	500	....	..	..	...
	4	Lounge	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	......	500	....	..	..	...
	2	Buffet-Chair	6-1935	Ice	R. R. Co.	......	Ice	1	4	Flat belt	Body	Edison	500	....	....	..	...
Western Pac.	4	Coaches	6-1935	St. ejec.	Safety C. H. & L.	......	Water	2	1-3 1-4	Flat belt	Body	Edison	600	....	..	..	...

[1](B. & O.) Three-car Diesel motor train.

[2](B. & O.) Light weight trains.

[3](B. & M.) Three-unit articulated Diesel-electric train.

[4](C. M. St. P. & P.) Streamlined cars.

[5](C. B. & Q.) One unit of streamlined train.

[6](C. B. & Q.) Units of streamlined train. One generator and one battery per train.

[7](G. M. & N.) Units of streamlined train. Single 80 kw. auxiliary generator driven by main engine supplies current for train.

[8](N. Y. N. H. & H.) Three-unit streamlined train with two separate air-conditioning units, each serving one-half of train. Power furnished by one auxiliary generator on each of two main power plants.

[9](St. L.-S. F.) Cars are equipped with motor-generator sets for charging batteries.

[10](S. A. L.) Equipped with auxiliary holdover.

[11](S. A. L.) System uses one 6-volt, 80 amp.-hr. battery for starting gasoline engine on Freon compressor. Lighting load carried by 12-V., 1,200 watt generator on main engine and 12-V. battery.

Summary of 1935 Air Conditioned Cars by Types of Cars

Name of Railroad	Total Cars	Coaches (Note A)	Combination (Note B)	Dining (Note C)	Business	Lounge-Diners (Note D)	Chair	Observation (Note E)	Sleeper-Chair	Sleeping Cars (Note F)
Alton	7	..	2	..	..	5	..	..	..	..
A. T. & S. F.	77	8	..	4	..	3	62	..	..	..
A. C. L.	15	15	..	..	..	..	..	..	..	..
B. & O.	72	36	14	2	1	13	4	2	..	..
B. & M.	15	15	..	..	..	..	..	..	..	..
Cen. of Ga.	4	2	..	..	..	2	..	..	..	..
C. & O.	19	14	..	2	3	..	..	..	..	..
C. & E. I.	4	..	..	2	..	2	..	..	..	..
C. M. St. P. & P.	68	38	..	6	..	..	10	..	..	14
C. B. & Q.	64	23	..	10	..	..	31	..	..	..
C. & N. W.	70	48	10	..	..	1	9	2	..	..
C. St. P. M. & O.	13	4	..	5	..	4	..	..	..	..
C. R. I. & P.	27	..	..	6	..	6	15	..	..	..
D. & H.	1	..	..	..	..	1	..	..	..	..
D. L. & W.	12	10	..	..	1	1	..	..	..	..
D. & R. G. W.	20	16	..	..	..	4	..	..	..	..
Erie	1	1	..	..	..	..	..	..	..	..
Fla. E. C.	11	8	..	3	..	..	..	..	..	..
Ft. W. & D. C.	14	10	..	4	..	..	..	..	..	..
Great Northern	16	12	..	4	..	..	..	..	..	..
G. M. & N.	5	1	..	..	..	2	..	..	..	2
Illinois Central	44	2	7	18	1	14	2	..	..	..
Lehigh Valley	12	4	..	3	..	2	3	..	..	..
L. & N.	5	..	..	5	..	..	..	..	..	..
M-K-T	5	..	..	2	..	..	3	..	..	..
Mo. Pac.	111	52	8	4	1	25	21	..	..	..
N. Y. C. System	58	47	..	11	..	..	..	..	..	..
N. Y. C. & St. L.	3	3	..	..	..	..	..	..	..	..
N. Y. N. H. & H.	146	132	6	6	..	..	2	..	..	..
Nor. & Wn.	34	22	8	4	..	..	..	..	..	..
Nor. Pacific	26	16	..	6	..	..	..	4	..	..
Pennsylvania	93	48	26	16	..	3	..	..	..	..
Pullman Co.	1828	..	..	..	..	..	..	8	262	1558
Reading	21	12	5	4	..	..	..	..	..	..
C. R. R. of N. J.	13	10	..	3	..	..	..	..	..	..
R. F. & P.	10	8	2	..	..	..	..	..	..	..
St. L.-S. F.	40	15	2	7	2	..	12	..	2	..
Seaboard A. L.	33	18	8	6	1	..	..	..	..	..
Southern	27	..	..	27	..	..	..	..	..	..
Southern Pacific	106	35	..	26	..	4	37	4	..	..
Texas & Pacific	44	34	..	5	1	..	4	..	..	..
Union Pacific	131	63	..	17	..	..	38	13	..	..
Wabash	20	..	..	..	..	4	16	..	..	..
Western Pacific	4	4	..	..	..	..	..	..	..	..
	3349	786	98	218	11	96	269	33	264	1574

Note A—Includes coach-club and coach-lounge cars.
Note B—Includes passenger-mail, passenger-baggage and club-baggage cars.
Note C—Includes cafe cars.
Note D—Includes cafe-club, cafe-parlor, cafe-lounge, cafe-coach and buffet-lounge cars.
Note E—Includes observation-chair cars.
Note F—Includes tourist-sleepers and sleeper-observation cars.

Summary of Cars by Types of Systems and Refrigerants Used

		Type of system				Refrigerant used			
Name of railroad	No. cars	Electro-mech.	Direct-mech.	Ice	Steam ejector	Freon	Water	Ice	Methyl-chloride
Alton	7	7	..	..	..	7	..	..	..
A. T. & S. F.	77	..	..	..	77	..	77	..	..
A. C. L.	15	3	..	..	12	3	12	..	..
B. & O.	72	72	..	..	..	72	..	..	..
B. & M.	15	15	..	..	..	15	..	..	..
Cen. of Ga.	4	..	..	..	4	..	4	..	..
C. & O.	19	..	19	..	..	19	..	..	..
C. & E. I.	4	..	..	..	4	..	4	..	..
C. M. St. P. & P.	68	..	..	..	68	..	68	..	..
C. B. & Q.	64	43	4	17	..	47	..	17	..
C. & N. W.	70	12	1	57	..	1	..	57	12
C. St. P. M. & O.	13	..	..	13	..	..	..	13	..
C. R. I. & P.	27	..	..	27	..	..	..	27	..
D. & H.	1	..	..	1	..	..	..	1	..
D. L. & W.	12	..	10	2	..	10	..	2	..
D. & R. G. W.	20	..	..	20	..	..	..	20	..
Erie	1	..	..	..	1	..	1	..	..
Fla. E. C.	11	..	..	..	11	..	11	..	..
Ft. W. & D. C.	14	14	..	..	..	14	..	..	..
Great Northern	16	..	..	16	..	..	..	16	..
G. M. & N.	5	5	..	..	..	5	..	..	..
Illinois Central	44	..	34	10	..	34	..	10	..
Lehigh Valley	12	12	..	..	..	12	..	..	..
L. & N.	5	..	..	..	5	..	5	..	..
M-K-T	5	..	..	3	2	..	2	3	..
Mo. Pac.	111	4	..	86	21	4	21	86	..
N. Y. C. System	58	58	..	..	..	58	..	..	..
N. Y. C. & St. L.	3	..	3	..	..	3	..	..	..
N. Y. N. H. & H.	146	90	..	56	..	90	..	56	..
Nor. & Wn.	34	30	..	..	4	30	4	..	..
Nor. Pacific	26	..	26	..	..	26	..	..	..
Pennsylvania	93	23	..	70	..	23	..	70	..
Pullman Co.	1828	259	882	433	254	1141	254	433	..
Reading	21	21	..	..	..	21	..	..	..
C. R. R. of N. J.	13	13	..	..	..	13	..	..	..
R. F. & P.	10	7	3	..	..	10	..	..	..
St. L.-S. F.	40	..	..	40	..	..	..	40	..
Seaboard A. L.	33	1	32	..	..	33	..	..	..
Southern	27	..	..	..	27	..	27	..	..
Southern Pacific	106	..	..	98	8	..	8	98	..
Texas & Pacific	44	1	1	20	22	2	22	20	..
Union Pacific	131	15	91	..	25	106	25	..	..
Wabash	20	..	..	20	..	..	..	20	..
Western Pacific	4	..	..	.	4	..	4	..	..
	3349	705	1106	989	549	1799	549	989	12

EDITORIALS

Is Accuracy Worth-While?

Control over the cost of locomotive repairs involves, first, good locomotive design and, second, the development and adherence to methods of parts production and assembly such as will assure a continuance of standards proved by experience to be worth while. Economy in maintenance demands interchangeability of parts and interchangeability demands accuracy of dimension. It is, therefore, not at all surprising to find the more progressive railroad shops today demanding standards of accuracy that would have been considered impossible of attainment a few years ago. Where one finds low repair costs there is usually found, at the same time, a high standard of accuracy in shop work.

There are still many people, both in and out of the railroad industry who believe that accuracy, in a railroad sense, means "yardstick" measurements and it would prove quite startling to such people to observe methods in some of our shops which involve production to tolerances which are impossible without the use of precision measuring tools.

Because of the rather "rough" nature of a large part of locomotive assembly work it has been a difficult job to educate mechanics to the value of greater accuracy but in those shops where the educational process has taken place it would be just as difficult to change back to the old inaccurate standards. It has been found that no matter how skillfully a good mechanic might use ordinary calipers an average mechanic with micrometers and gages can produce more accurate work. It has also been found that, having become accustomed to the use of precision instruments and producing work to precise dimensions, many mechanics who formerly were satisfied with mediocre work now take pride in producing exceptionally good work.

But, having educated mechanics to work to small tolerances and having provided them with precision measuring instruments, it has also been found that there are many railroad shop machine tools that are not capable of producing accurate work under any circumstances due to the fact that they have long since reached a condition where the wear of parts permits lost motion or has caused misalignment of important units of a machine.

In one shop where, over a period of three or four years, there has been an intensive effort made to produce more accurate parts the introduction of precision measuring instruments provided the first really accurate check they had ever had on the machine tool equipment of the shop and the supervisors were astonished to see how impossible it would be to turn out work to the tolerances now demanded. As job after job was tooled up for production it first became necessary to go all over the machines, line them up and overhaul them. It also resulted, in the case of several machines, in retiring them and replacing them with up-to-date equipment. Now it is possible to get increased production which meets the required standards of precision and at a much reduced cost.

Accuracy of lay-out in the erecting shop and close tolerances in machine work permit interchangeability and thereby make possible quantity production at savings which are an incident thereto. Adherence to standard dimensions broadens the range of use of a given part and thereby reduces stock inventory. The accuracy of workmanship demanded by close tolerances makes it necessary to keep a constant check on the condition of shop equipment and the habit of production to precision measurements has the psychological effect of causing a workman to take pride in better workmanship. All things taken into consideration, accuracy is worthwhile.

The Mechanical Associations

Our readers will recall that a considerable portion of the January number of the *Railway Mechanical Engineer* was given over to messages from the leaders of the mechanical-department associations and to a supporting editorial entitled, "1936 'Forward!' 'March!'"

Comments on these expressions are still coming in. In general, they indicate keen appreciation for the effort that we are making to revive and stimulate the work of the so-called minor mechanical department associations. In a number of instances this commendation was coupled with specific suggestions, particularly relating to the importance of these organizations in educating the officers and supervisors to a better understanding of their problems. This, of course, is particularly important to men who have been promoted to supervisory positions in the past few years, or who may be promoted as business continues to improve.

A few of the letters are critical, in some instances as to details and in other instances as to broader policies. The suggestion is made that possibly a study might indicate that some of the weaker associations can be done away with, while others may be consolidated. The latter suggestion is particularly strong in relation to the Traveling Engineers' Association and the International Railway Fuel Association.

Among the broader criticisms is one to the effect that the members of the minor associations, not understanding fully all of the problems involved in the broader aspects of railroading, sometimes make statements which may be misunderstood and are not in the best interests of the railroads. There may have been

instances of this sort, but in our opinion, from an intimate study of the associations over many years, they have been few and far between and are insignificant as compared to the great good that has been accomplished for the railroads by these organizations.

The railroad cause will never be seriously embarrassed by a free and open discussion of all of the problems involved, and particularly of those concerned with the operation of the technical branches. Since the railroad question has become to so large an extent a public question, we must expect criticism, particularly if any really worthwhile, forward progress is being made. Since it is part of the program we might just as well make up our minds to it, and meet it by adopting a constructive program to educate the public and the employees to the real facts.

One suggestion with which we cannot agree is that the minor mechanical associations be brought directly under the Mechanical Division and become an integral part of it. Frankly, we do not believe that this will be in the best interests of the mechanical departments or of the railroads. The Mechanical Division, as it is now constituted, devotes practically all of its energies to the formulation of standards and recommended practices. It has settled down to a machinery-like process and has lost much of the vigor and sparkle that characterized it when it was on a more voluntary basis and had broader outlook and objectives.

We believe that a very vital part of the work of the minor associations is that of inspiring their members, giving them a larger and broader vision and stimulating them to more intensive efforts. The work of these associations is largely educational and in no sense can be compared with the work of the Mechanical Division or the Association of American Railroads as a whole. It can, however, be made a very vital adjunct to the work of these associations, if they are maintained on a voluntary, independent basis. They can be relied upon to co-operate with the Mechanical Division when the need arises.

Two Things Which Are Not New in 1936

The old adage that "there is nothing new under the sun" is borne out by many experiences and trends in present-day railroading, two of which may be mentioned. The demand for high train speeds, for example, implies motive power designed for this service, one of the requirements being relatively large diameter driving wheels. In recent years, the diameters of steam locomotive driving wheels for both passenger and freight service have been substantially increased, the maximum being 7-ft. wheels such as are on the Milwaukee's "Hiawatha". Driving wheels of this size were by no means uncommon in an earlier day of railroading, however, and it may be surprising to some of our readers to learn that during the period 1860-65 a considerable number of locomotives were placed in service with 8-ft. driving wheels; one, the "Allan Crewe" in England, had 8-ft. 2-in. driving wheels.

Similarly, the current discussion regarding taper tread versus cylindrical tread wheels is no novelty. The following is quoted from the Railroad Gazette of April 16, 1870:

> Every one knows that the outer rail of a railroad track is longer than the inner one, and the coning of the car wheel, or the gradual increase of its diameter of tread toward the flange, is intended to facilitate the motion of the cars around a curve. Thus a fast express train will press more against the outer rail than the inner, and by reason of the increased diameter of the tread near the flange of the outer car wheel, the outer wheel will move further per revolution than the inner one.
>
> This would seem to be an indisputable argument in favor of the coning of car wheels, and it has been so universally the practice on railroads that it seems hardly credible that there should be anything incorrect about it. There are, however, very weighty arguments against the practice. In the case of freight cars, the coning would act injuriously rather than beneficially, because it is against the inner rail that these cars have a tendency to press. But supposing the question is confined to the expediency of coning the car wheels for fast passenger trains only, we find that the coning acts injuriously on the straight portions of the road, the wheels running up against one rail on to the largest diameter of the tread, and then against the opposite rail on to the largest diameter of the tread of the opposite wheel, and so on, first against one rail and then the other, producing an oscillation which is both disagreeable to the passengers and expensive to the stockholders of the road.
>
> Again, of how much value is the coning on curves? It is extremely small. On a railroad like the Hudson River or New York Central, the radius of the curves is very large, one mile being very common—in fact curves of a less radius than this are more seldom met with than curves of a larger radius. The diameter is, of course, twice the radius, and the circumference, or length of a complete circle, three and one-seventh times the diameter; thus a curve with a one-mile radius would be six and two-seventh miles in length. Now, the difference between the circumferences measured on the inner and outer rail is always equal to the circle having as radius the distance between the two rails. Thus, in the case of a broad gage road, whose gage is six feet, the difference between the length of the outer and inner rails is only a trifle over 18 ft. in a complete circle, no matter what the diameter of that circle. In the case of a curve whose radius is one mile, the length is something over six miles, as stated above, and a car wheel in passing over this six miles of curve would have to slip about eighteen feet if it had no coning. A curve on a road is never complete, however. One-sixth of a circle, with radius of one mile, would be an ordinary curve and its length would be one mile, and the difference in the length of the rails about three feet. Hence the question arises, is it not better to use wheels with a flat tread, causing a very little slip on curves, and very little oscillation on the straight portions of the track, rather than coned wheels, whose efficiency is somewhat doubtful on curves, and which cause injurious oscillation on straight portions of the track.
>
> This question must be decided one way or the other, according to the circumstances. For instance, on some roads the straight portions of the track are the exception, and curved portions the rule; hence coned wheels might be considered necessary. On other roads there might be a very few extremely sharp curves, and coned wheels might be necessary here. * * * In conclusion, it is extremely doubtful if the present system of coning is beneficial, and cars with wheels having a

flat tread have been tried and reported favorably on by the superintendent of one of our western railroads.

The Illinois Central has used cylindrical tread wheels on its multiple-unit electric trains with good results for several years. The Chicago, North Shore & Milwaukee has recently standardized on this tread contour which is also being used on numerous light-weight high-speed trains operating in various sections of the country. The indications are that for standard heavy equipment, a smoother operation is secured, all things considered, with taper tread tires, owing to the fact that the weight of the equipment provides substantial components of force tending to hold it central on the track. In the case of light-weight equipment, however, experience indicates that truck nosing and transverse oscillation of the car wheels from rail to rail is substantially reduced by using cylindrical treads.

Light-Weight Passenger Equipment

The first of the light-weight, self-propelled, articulated trains, built about two years ago, were designed with a view to demonstrating the possibilities of weight reduction in passenger equipment for high-speed service by the employment of special materials—the strong alloys of aluminum in the case of the train built for the Union Pacific and high-tensile stainless steel in the case of the Burlington train. In order that the demonstration might be impressive the cross-sections of the body units were reduced in width and height, and flexibility of train consist was completely sacrificed to the interests of weight reduction by the employment of the articulation principle of joining the body units. The two trains, each with three body units, complete with 600-horsepower Diesel-electric power plants, weighed slightly more than 100 tons each, thus providing more than five rated horsepower per ton of total train load. As later trains have been built with more body units the horsepower ratio has declined. In the case of the seven-unit train on the Union Pacific, with a 1,200-horsepower Diesel-electric power plant, there is approximately 4.5 horsepower per ton, and, with the four-unit Mark Twain Zephyr of the Burlington, 4.2 horsepower per ton.

These trains with their high power-weight ratio as compared with heavy main-line steam passenger trains demonstrate impressively what weight reduction and ample power can do in speeding up passenger-train movement and reducing train-mile costs. The lack of flexibility in train make-up, however, presents a serious handicap in fitting such trains successfully into a traffic situation in which improved facilities and higher speeds tend to build up the patronage.

The orders for motor trains recently placed by these same railways mark the evolution of this type of construction from a unit adapted only to a highly specialized situation into railway passenger equipment of full stature in which the flexibility of separate coach units has been restored. The trains with ten revenue body units and separate Diesel-electric locomotives (2,400 horsepower on the Union Pacific, and 3,000 horsepower on the Burlington) will probably retain a horsepower-weight ratio of four or better. The use of the articulation principle has been retained to join bodies into two- and three-unit coaches, thus effecting a considerable saving in truck weight without a complete sacrifice of flexibility.

Both of these trains are destined to operate on schedules much faster than those now prevailing. So long as the consists of the trains are not expanded, they will no doubt maintain these schedules successfully. Should, however, a growing popularity of the service dictate the addition of more cars, more powerful locomotives will have to be used or the necessary margin of power will be sacrificed. Long-distance schedules of over 60 miles an hour can scarcely be maintained with a ratio of three horsepower per ton or less, common in heavy main-line passenger service today.

A significant step in the reduction of the weight of passenger equipment is represented by the stainless-steel coach of the Atchison, Topeka & Santa Fe, a description of which appears elsewhere in this issue. This is not the first coach in which substantial reductions in weight have been effected by the use of new materials. There are the Abraham Lincoln and the Royal Blue trains of the Baltimore & Ohio, and the Rebel trains of the Gulf, Mobile & Northern. The coaches in these trains, however, have been specially fitted so that they are not readily interchangeable with other standard coaches. The Cor-Ten-steel coaches of the New York, New Haven & Hartford and the Boston & Maine and the welded coaches of the Chicago, Milwaukee, St. Paul & Pacific all represent substantial savings in weight of cars intended for operation interchangeably with the older equipment. But the Santa Fe car is the first car intended to be thrown into the trains of heavy standard equipment, in which full advantage has been taken of the possibilities for weight saving developed in the stainless-steel articulated train structure. These and the welded coaches of the Chicago, Milwaukee, St. Paul & Pacific also embody an end formation which has rarely been seen on coaches in America. The straight longitudinal roof lines at the ends are suitable for use with outer diaphragm closures and, even without these, should tend to induce less air turbulence between cars than the present conventional hooded ends.

With the dropping of the clerestory, which is no longer needed with the forced ventilation adopted with air conditioning, some consideration will soon need to be given to the question of a standard sectional contour if for no other reason than to avoid the unsightly appearance which conflicting contours would produce when combined in the same train. There is the further important consideration, however, that the ultimate use of outer diaphragms will be seriously retarded unless a standard contour is adopted.

THE READER'S PAGE

Pound Foolish

To the Editor:

Your December number has a story called "Pound Foolish." Although fiction, it is true to every-day happenings.

Of course we all know that the mechanical department carries the biggest load, and that if the stores department would keep up with it, things would run a lot more smoothly. What is more irritating than to be in a hole—held up for materials—and upon entering the storehouse find the storekeeper sitting with a big smile on his face, like a king on top of the world, not seeming to realize how serious the condition is.

I remember an occasion during the Century of Progress Fair in Chicago, when passenger power was badly needed. We had two of a certain type of engines at the shops, one held for tire turning and the other for general repairs. When the tires on the first engine were being turned we found a check in the main axle. The first move was to see whether the stores department had received the last shipment of axles. It was the same old story: "Expect them to arrive any day now; will send a tracer or wire."

To make a long story short, we removed the main wheels on the second engine, rebored the boxes to fit, turned the tires to suit, ground the pins, took the eccentric rods and fitted them to the eccentric cranks of these axles, and replaced the wheels with the cracked axle. We used up enough man-hours to pay for two axles.

I recall an occasion in another shop when an important engine was being held up waiting for a set of piston packing rings. There were no overhead cranes in the shop. The tire turning lathe was served by an air hoist, the cylinder of which was 22 in. in diameter.

A trip to the stores department was rewarded with the statement: "Expect castings in early next week. (They seemed quite content that they were that near.) What do you guys over there expect? You used more ring castings last month than during the past six months."

"Yes," we replied, "but the stores shipped all the rings out on the road. You don't blame the shops for that, do you?"

And so, on and on, the old argument goes.

In the meantime the general foreman busied himself. "Joe," he said, "take down that air hoist from the wheel lathe and cut it up into 24-in. cylinder packing for 7409. She must be out of here tonight."

"But," said Joe, "how are you going to get the tires turned for 8492? She will be ready for wheeling day after tomorrow."

"How would you do it if the air compressor broke down?"

"Well, I guess we'd have to jack the wheels in and out."

"Well, go ahead any way you like best. Get the packing rings done tonight and the tires by the time they are needed."

Both jobs were done on time, but at what a cost! It was two weeks before another air hoist cylinder was completed.

These are typical of some of the little things which happen frequently. Too often we enter the storehouse and find empty shelves. An inquiry as to whether a particular part had been ordered is met with a reply that it will be done by the twentieth of the month, when the general check-up takes place.

I believe that every storekeeper should have a working knowledge of the mechanical department, thus enabling him to supply the materials on time and keep the wheels turning without so much grief to the mechanical department.

Jim Evans, the roundhouse foreman in your story, seemed to be out of luck all the way around. Jim should have larger sleeves so that he could tuck away certain parts for emergencies.

I do not believe in stocking the store shelves with materials that will in time become obsolescent, but I do believe every storekeeper should keep the polish off the seat of his pants. There is an old saying that, "When a workman slows up beyond reason he needs a shot in the arm to pep him up."

We really do like the fellows in the stores, for they are a jolly, good-natured bunch and are willing to do all in their power to help us over the rough spots, although it must be admitted that they are partly responsible for our being in these spots. A lot of cooperation could be used to eliminate waste time and man-power.

Foreman.

Why So Many Obsolete Locomotives?

To the Editor:

The chart reproduced in the advertisement of The Baldwin Locomotive Works is worthy of more serious thought than any other item in the January *Railway Mechanical Engineer*. In studying it, the question that naturally arises is, just why has the construction of steam locomotives in the United States almost ceased? This situation cannot be charged entirely to the financial condition of the railroads. Net earnings of railroads in other countries have also shown a marked decline from the figures recorded in more prosperous days, but nowhere has the renewal of the locomotive stock been neglected to the same extent as in the United States. In Great Britain, for example, approximately 4,500 new steam locomotives have been placed in service by the four main lines during the ten years from 1926 to 1935, inclusive. This represents about 22 per cent of the present locomotive stock of those railways. True, this percentage of replacements is still somewhat below normal, but it appears huge by comparison with the 7.8 per cent credited to the U. S. A. during the same period.

One thing that has been done in Great Britain might be applied with profit in America. I refer to the consolidation or grouping of railways, which has brought about a greatly improved motive power situation. The total number of locomotives necessary to move a given amount of traffic has been substantially decreased, and what is more important, the number of different locomotive classes in use has been greatly reduced. Complete

and rigid standardization of locomotive types is neither possible nor desirable, nor would any well-informed critic advocate consolidating all railways into one concern, whether operated privately or by government, but it is apparent that the highest economic efficiency cannot be attained with our present organization involving some 50 large systems, each purchasing engines in small groups, with more or less extensive differences between engines on adjacent lines in the same territory, and similar differences between successive orders for engines to be used on the same railway.

American railways seem to have no great difficulty in finding money for expenditures, which, in the light of past experience, are of debatable value from the standpoint of net earnings. I am somewhat puzzled at the sight of large sums being spent in a frantic effort to retain or regain passenger traffic, which in former years, with higher fares and under less expensive methods of operation, was generally considered unremunerative, while at the same time the great bulk of the locomotive stock is allowed to drift into obsolescence. Have the railroad managements concluded that some other form of motive power will shortly supersede the steam locomotive? Are they cautiously awaiting further developments which may lower the first cost and increase the dependability of the oil-electric locomotive? If so, they had better make a careful survey of the available oil supply before acquiring any considerable stock of internal-combustion engines. The known reserves of good coal in the ground are sufficient for an indefinite period, but the same cannot be said of our petroleum reserves. If we continue to use and waste oil at the present rate, the day may come in the not distant future when the increasing price of oil will force a return to coal in those regions where it is now unknown as a locomotive fuel.

One of the most noticeable features of recent American locomotive construction is the almost complete concentration on production of units of maximum power. An article in the May, 1934, *Railway Mechanical Engineer* shows that something over 40 per cent of the steam road locomotives in *active service* during August and September, 1933, were of the smaller and lighter types; 2-8-0, 4-6-0, 4-4-0, 4-4-2, 2-6-0 and 2-6-2. This would indicate that there is a definite place for efficient engines of medium power in present-day railroad operation. The large number of middle-aged, semi-obsolete *big* engines running about the country at the head of abbreviated trains only serves to confirm that indication. But the requirements cannot be filled properly by engines whose average age runs from 25 to 30 years. Vast savings in maintenance and fuel costs could be realized by replacing these old-timers, not with remodeled big engines working far below their nominal capacity, but with new engines specifically designed for the required power output.

Some railways, which are too well known to require enumeration, have a stock of switching locomotives which is sadly out of date. Saturated engines, with slide valves and Stephenson link motion, conforming to the accepted practice of 30 to 35 years ago, may still be found at work in more than one yard. I have in mind one large western railway, which has not bought a new steam switching locomotive in more than 20 years. Its yard work is largely performed by old 2-8-0 engines, long ago retired from road service, some of which date back to the middle nineties. Having light axle-loads and any amount of play in their running and driving gear, these engines are easy on the track and take curves and switches with facility. Superheaters have been applied to them, and their owners are no doubt convinced that great savings are realized by prolonging their lives indefinitely. Without going very deeply into the economics of the question, one has only to observe the performance of these ancient Consolidations and then contrast it with the work of up-to-date 0-6-0 and 0-8-0 locomotives on neighboring lines, to conclude that great improvement is possible, putting it very mildly.

Sooner or later, something will have to be done about that 62.5 per cent left over from pre-war days. The locomotive builders, whose very existence is at stake, have been hammering away on this subject for a long time. It is encouraging to note the support they are receiving from the Railway Age.

WM. T. HOECKER.

Bootleg Tool Steel

TO THE EDITOR:

Some months ago I had an opportunity to visit a shop at a distant point on our line and in the course of my trip through the plant saw a man operating a heavy duty lathe. It struck me that I had seen him somewhere and I walked around to a point where I could get a good look at him and the work he was doing.

The operator was none other than Slim Wheaton, who had worked over on the "East End" about 16 years ago. By way of opening a conversation and to determine if he remembered me, I casually walked over to his machine and said: "Judging from the speed of the machine and the color of the chips, I see you are running her in 'high' today."

Slim straightened up and turned his head momentarily to discharge an overload of "Star" juice and replied. "It is easy to take a cut that is a cut and run her in high when you have tool steel like that."

"It looks just like any other tool steel from here." I replied.

"Well, Mister, you are badly fooled if you are going to judge a tool steel by looks, because performance is what that kind of steel is famous for."

"If it is as good as you say it is, Slim, I wish you would tell me all about it."

He proceeded to tell the whole story. He got the steel from a former buddy who was previously cut off in a force reduction and went out to the oil fields and found it in use there on heavy oil well tools. He liked it so well that he just didn't bother to throw out three or four pieces that happened to be in his kit when the work in the oil fields ended.

When he returned home he told Slim about his experiences and praised the tool steel enough to get Slim's curiosity aroused to the point that Slim borrowed it from him and liked it so well that he was using it exclusively. His only worry seemed to be what was he to do when it was used up.

It is just as natural for good mechanics to gravitate to good tools as it is for water to run down hill. There are a number of good tool steels that will pay for themselves many times over before they are worn out or used up.

OBSERVER.

BELIEVE IT OR NOT—The Norfolk & Western vouches for this one. A little girl on one of their air-conditioned trains, on a blistering hot afternoon, looked out of the window and remarked: "Those boys out there certainly picked a cool day for swimming."

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Prompt Results From Convention Attendance

I have been impressed, too, with the rapidity with which ideas and devices discussed in associations like the International Railway Fuel Association and the Traveling Engineers Association find their way into practice. Evidently a considerable proportion of those in attendance go home and promptly test under their own conditions the things which they have heard discussed.

Technical Graduates on Railroads

I feel that one of the crying needs of the railroad industry is to bring in young men and to give such as are brought into the industry a broader line of instruction and guidance than has characterized the efforts of the industry in the past. I have in mind particularly technical graduates. It is my belief that technical graduates should be used by the railroads in other than engineering activities, as well as these.

Robbing Dead Engines

I like the Walt Wyre stories. While they may be a little exaggerated, anyone who has worked in a roundhouse can certainly enjoy reading them, since there are many situations in them that are encountered by roundhouse foremen. For example, last month I was on the day foreman's job. The storehouse not having material, it was necessary to rob three dead engines so that the other engines might be kept in service. A lot of extra work for a little material!

Use Your Head

We find the "Kid Glove Foreman" (January, 1936, page 34) working at the tramming of the drivers when he should have been overseeing or supervising. A supervisor should realize that whenever he elects to do the work no one is supervising his gang. While he may be making great headway on that particular job, the rest of the plant is literally going to hell. It takes a long time for some foremen to learn that the work belongs to the craft and that his business is to see that they are doing the work in an approved manner.

Many Supervisors Isolated

The supervisory forces located in the large railroad centers where they have an opportunity to visit with their neighbors and exchange ideas, or where there is a railway club, at the meetings of which good papers are presented and discussed on practical and technical subjects, have an advantage over the supervisor at the small town division point. The latter never gets out or sees anyone with whom he can exchange ideas or learn of the new mechanical appliances or devices that have been recently developed, unless some supply man comes along, and most of these have only been making the headquarters' towns in the last few years.

Keep Your Head!

As for the hat stomping ("The Kid Glove Foreman," January, 1936, page 34). I have seen that done more than once and always considered it so ridiculous that I have always felt that no matter what I lacked in other respects, I would never be that kind of a foreman. Foremen should ever be the coolest men on the job in every case, and especially in emergencies when the job is either won or lost in the course of a very short time. Anger drives out reason and always does more harm than good, and if the foreman has a few enemies it gives them a great deal of satisfaction "to get under his hide" and watch him literally "paw himself a hole in the floor," as one wag so aptly put it.

"Shimmying"

As regards Mr. Allen's article on rough riding (page 24, January issue), I believe he misses his step when he terms shimmying of a car due to one or two defects—eccentric wheels or clearance on truck chafing plate. Among truck men, the shimmy refers to just one thing—side shake due to wheels turned to the A. R. A. standard taper attempting to center on the track, with the result that they hunt or climb one taper and then the other, resulting in a twisting motion of the truck as one flange or the other hits the rail, which is communicated to the car with consequent unpleasant sideward vibration. The only corrective action anyone has found is to replace the outside pairs of wheels of truck where the shimmying occurs, which is an expensive procedure. It seems that very little wear is necessary to produce the shimmying condition.

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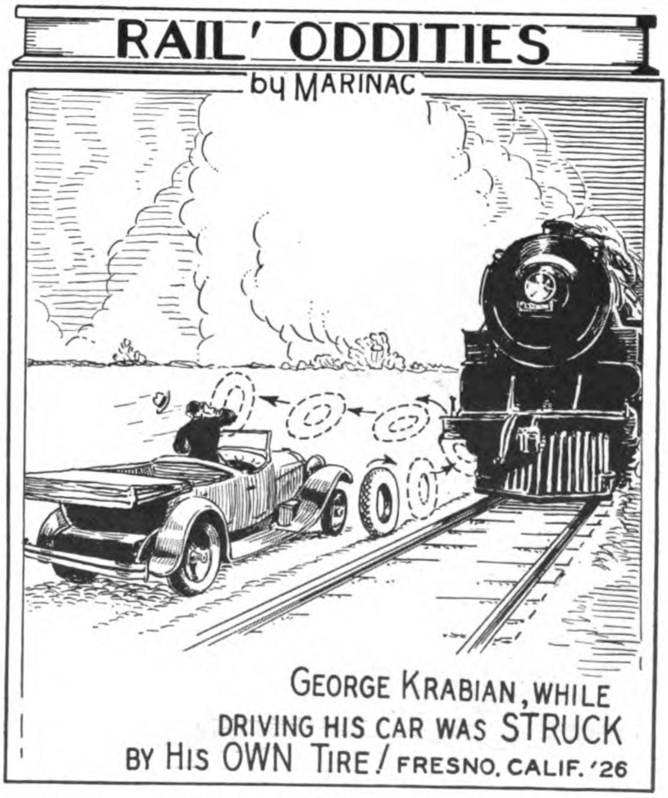


For explanation see page 134

With the Car Foremen and Inspectors

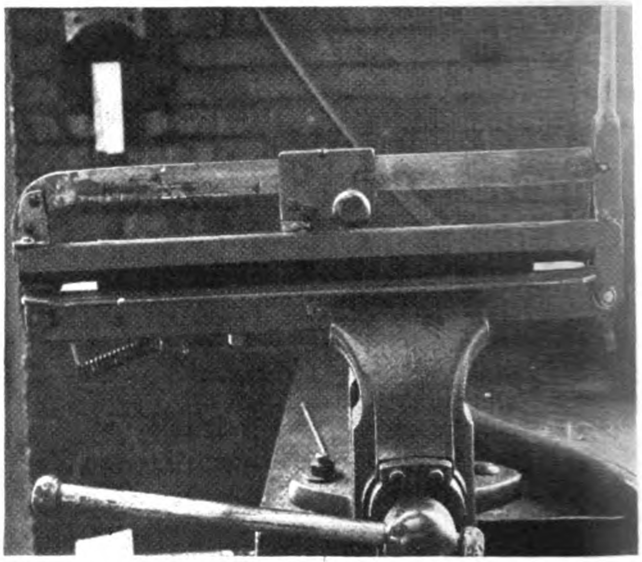
Tool for Slitting Air Brake Hose

It is common practice on quite a number of roads to apply sections of scrap air brake hose over various rods in the clasp-brake mechanism of passenger car trucks with a view to eliminating objectionable noises and also reducing the wear of these rods in metal guide brackets. In making these hose-guard applications, the hose are usually cut to the required length and slit with a hand-knife. They are then applied over the brake rods and wired in place, the guide brackets being widened where necessary to accommodate the increased diameter of the hose guard.

The hand slitting operation is a difficult one, owing to the tough material of which air brake hose is made, and there is also more or less danger of hand injuries in the operation. To overcome these difficulties, an ingenious device has been developed, as shown in the illustrations, and is now being used at the Omaha shops of the Union Pacific.

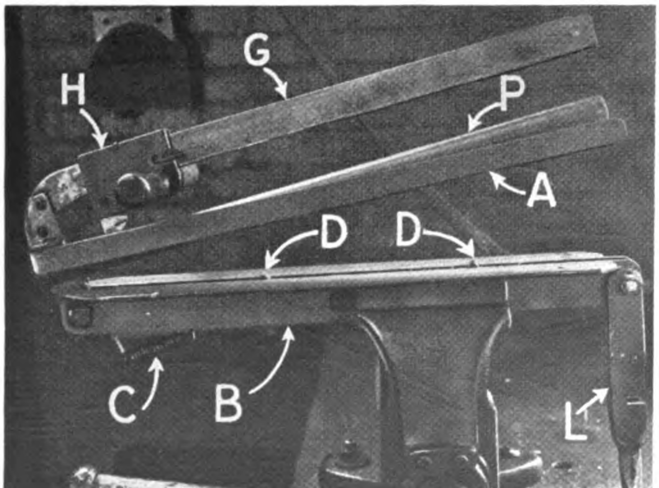
Perhaps the best idea of the construction of this device can be obtained from the view which shows it in the open, or unloaded, position. It consists of two 1½-in. base angles *B* 25 in. long, bolted together and held in the vise, with a hinged 1-in. pipe section *P* and a ⅜-in. by 1½-in. guide bar *G* which are always parallel and held in the upper position shown by means of the counter spring *C*. The slitting head *H*, moving freely on guide bar *G*, is provided with double handles and a knife edge which extends down into a groove cut along the top center line of pipe *P*.

In operation, the hose to be slit is applied over pipe *P* with the head *H* in the extreme left position and the parallel guide bar and pipe pulled down until the hose is compressed over holding dogs *D D*. The locking handle *L* is then swung upward and over the ends of pipe *P* and guide bar *G* so as to lock them in place. The operator stands at the right of the device and, by means of a single quick and strong pull on the handles, the hose is slit the full length and the momentum of the head *H* releases locking handle *L*, the guide bar and pipe fly up under the action of the spring mentioned, and the hose can be readily removed from the device. A



The tool in the closed position with a hose slit for about one-half its length

1-in. angle *A*, hinged on the left, is designed to be locked in handle *L* when the latter is in the upper position and serve as an additional holding feature on the hose. It is necessary to use this feature only when a second cut is to be taken in order to widen the slit and permit applying the hose guard around a brake rod of smaller diameter.



A tool used at the Omaha shops in slitting air-brake hose for use as brake-rod guards

How Passenger Trucks Cushion the Jolts

By separating the compact assembly of springs, rods, brake riggings, etc., of the passenger car truck into its component parts, the functions of the various springs, etc., can be easily understood. The spring system can be separated into two main parts: First, the spring assembly that takes up the jolts between the track and the truck frame, and, second, the spring assembly that acts as a buffer between the truck frame and the car body and thus allows the car body to "float" on springs suspended from the truck frame.

The truck frame and springs with the center form assembly removed are shown in Fig. 1. A jolt from a track irregularity passes into the wheel and thence into the journal box which slides up and down in the pedestal guides. An equalizer bar rests across the top of the two journal boxes of adjoining pairs of wheels and moves up and down with the boxes. A coil spring (the equalizer spring) takes up this motion and acts as a

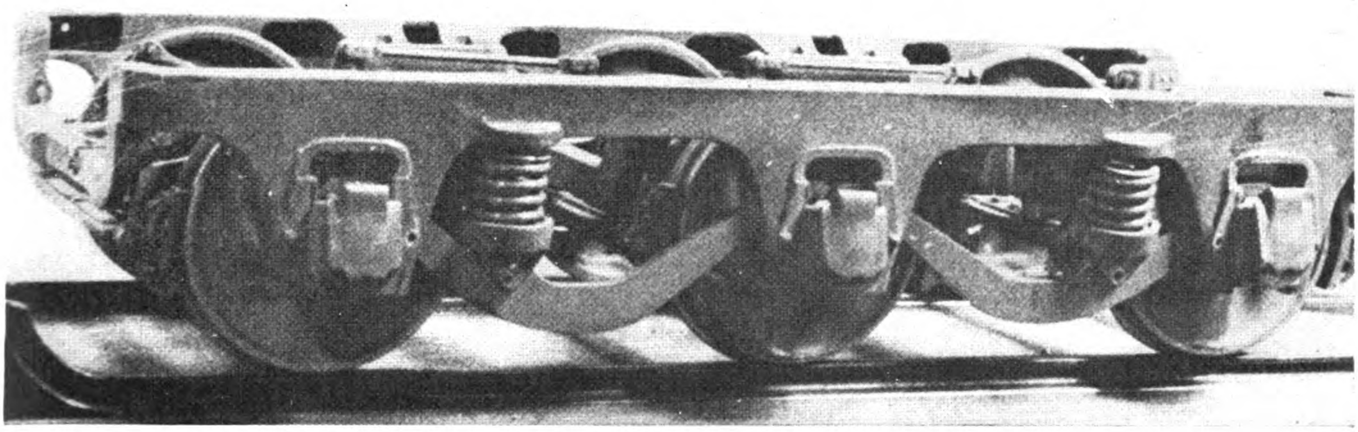


Fig. 1—Truck with equalizer bars and springs in place—Center form and bolster springs removed

cushion between the equalizer bar and the truck frame. The position of this coil spring (one-third of the distance between adjoining wheels) causes the equalizer bar to act as a lever and thus equalize the weight carried on each pair of wheels.

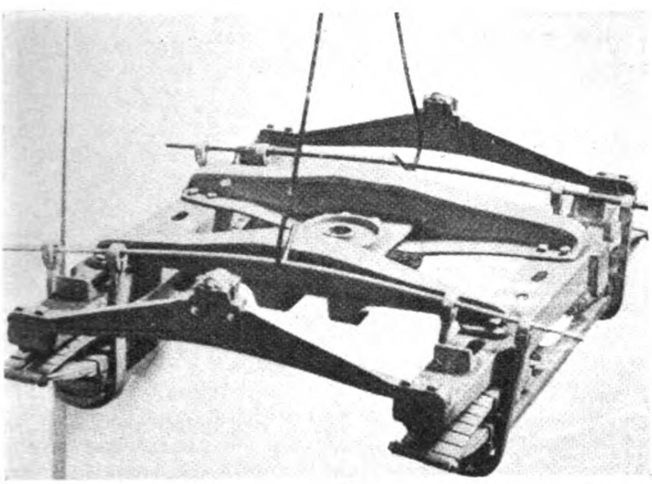


Fig. 2—Center form supported by bolster springs suspended from the swing hangers

The center form and elliptic springs which cushion the car body from the truck are shown in Fig. 2. This assembly is suspended from the truck frame by the four stirrups at the corners which are called swing hangers. Each swing hanger supports an elliptic spring (sometimes caller a "bolster spring") to which are fastened the center form with the center plate on which the car body rests.

The side arches connect the ends of the two bolsters of the six-wheel truck and support the side bearing rollers which prevent the car body from tipping by pressing against the side of the car frame. A "king pin" or pivot secures the car body to the center plate. The complete assembly of springs and parts in one design of a modern passenger car six-wheel truck is shown in Fig. 3. Thus we see that there are two complete spring systems operating in series between the truck wheels and the passenger car body. The coil spring system cushions rail shocks to the truck frame and the elliptic spring system still further cushions any shocks and dampens any vibrations which would otherwise be transmitted to the car body.

Odd Passenger

The latest in the transient world is the hobo snake. The Louisville & Nashville reports that it has heretofore been honored by being used as a means of locomotion by tramp dogs, cats, roosters and pigeons, but that it had never met a tramp snake until recently when a two-foot rattler was discovered riding on the coal tender of a southbound passenger train. A deep student of transportation matters, the serpent was making his way over the coal pile toward the engine cab when colored Fireman Enoch Fluker saw him. The rule book doesn't cover the matter of snake passengers, but Enoch has his own ideas on the subject; and the snake unwisely added insult to injury by making a sneering noise with his rattle. Aggrieved, Fireman Fluker fed him a fast one with the edge of his scoop and the snake rapidly became mincemeat.

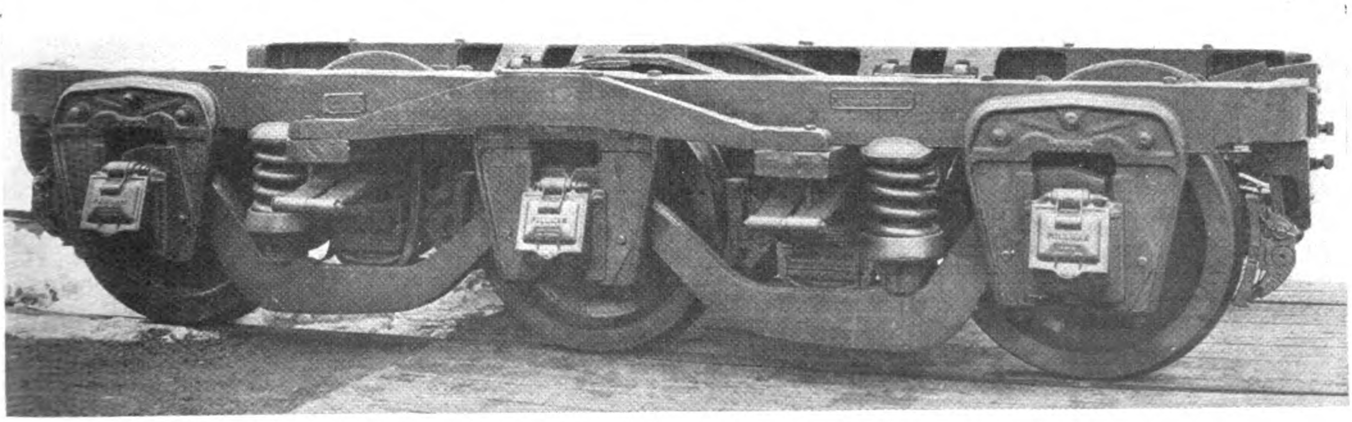
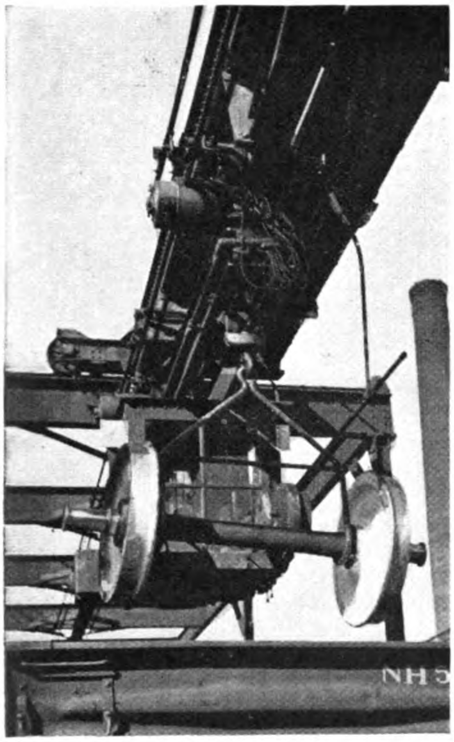
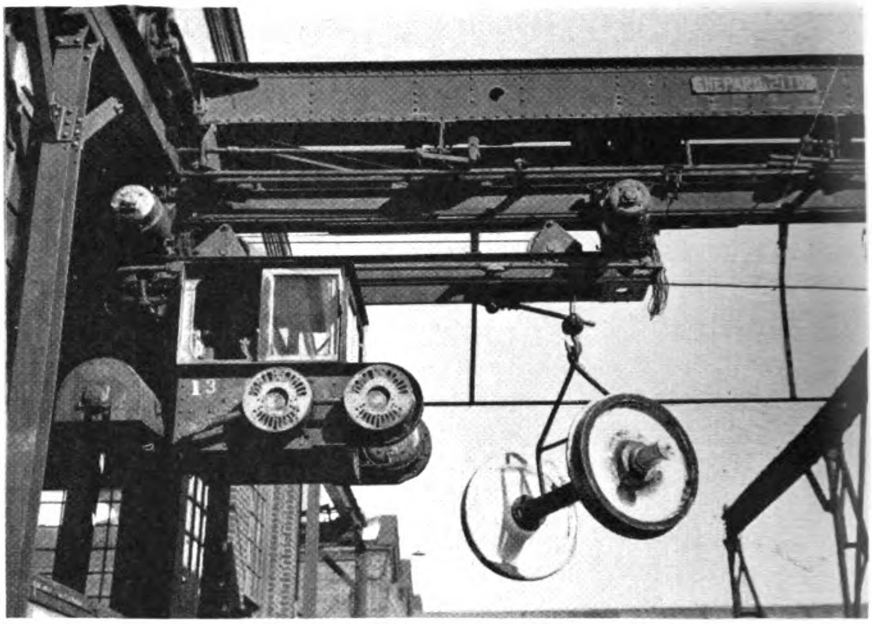


Fig. 3—Modern passenger car truck with center form and bolster assembled in place ready for service





At the left—a pair of finished wheels being loaded into a car by the monorail crane; Above—one of the monorail travelers on the bridge crane at the east end of the shop

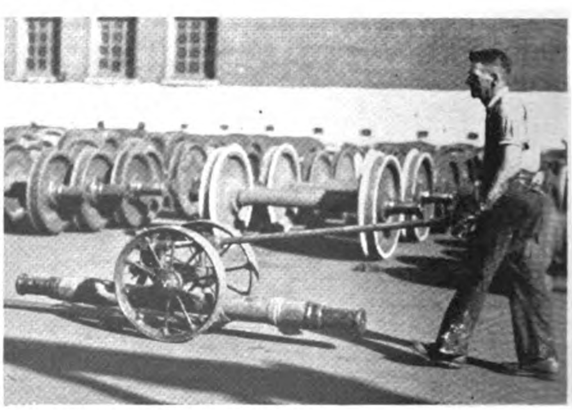
The New Haven

Readville Wheel Shop

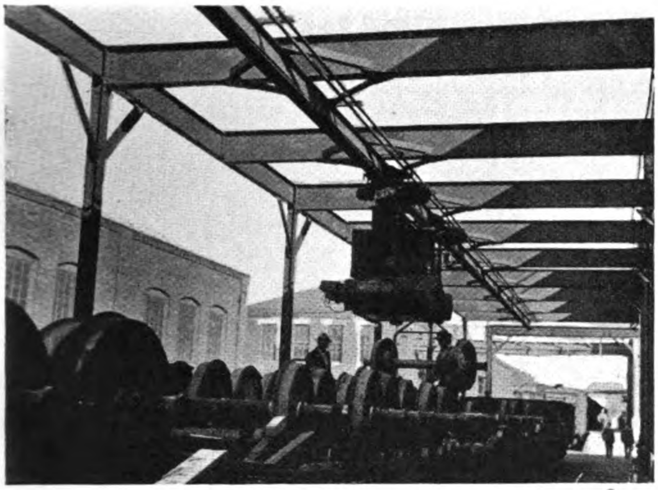
In order to control the quality of workmanship and to assure conformity with standards established by the A.A.R. the New York, New Haven & Hartford has centralized all of its wheel and axle work for the entire system at its Readville, Mass., wheel shop. In a plant equipped with modern facilities for handling wheels and axles an average force of 20 to 22 men perform the operations necessary to turn out an average of 50 pairs of wheels, ready for service, each working day.

The arrangement and character of the facilities at Readville may be seen by referring to the shop layout drawing and the illustration accompanying this article. The wheel shop is housed in a brick and steel structure 75 ft. by 200 ft. in size, of ample headroom to permit efficient handling by overhead hoists, and provided with an abundance of natural light. A standard-gage shop track serves one side of the shop where as many as five cars may be spotted at a time for the unloading of wheels arriving at the shop from outlying points or the loading of finished wheels which are ready to be shipped. The shop track is on the north side of the building and along this entire side there is a two-ton Shepard monorail crane runway. On the east side of the building there is a single-girder traveling crane with a span of about 20 ft. which serves the area along the east wall where wheels are stored. The monorail runway outside the shop connects with a similar runway in the shop through a door near the west end of the shop. The inside runway serves all of the heavy machines along the north wall and terminates at a door at the east end of the shop. These two runways and the traveling crane at the east end are designed so that either of two monorail travelers, each of two tons capacity and controlled by an operator in a cab on the traveler, may run out onto the traveling crane at the end of the shop at two points—at the ends of both the inside and outside runways. When a traveler is on the bridge girder of the traveling crane all of the movements of the crane—longitudinally along the runway, transversely along the bridge girder and the hoist movements—are controlled electrically by the operator.

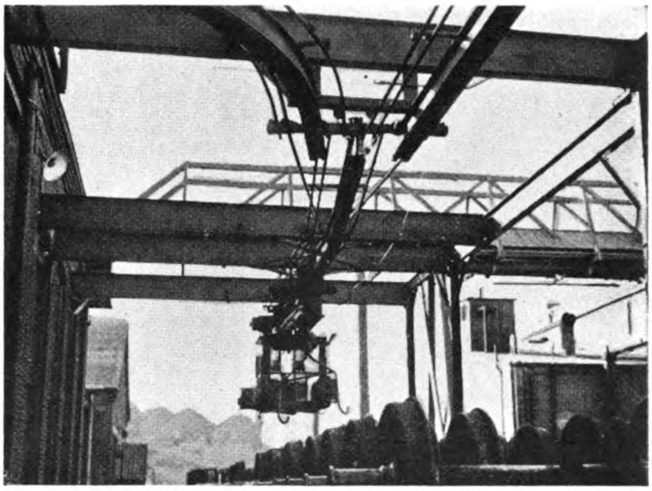
This monorail system, together with independent hoists and swinging cranes at individual machines throughout the shop, provides facilities which make it possible to handle mechanically practically all of the shop operations



Transporting an axle by hand



Defective wheels are unloaded from the cars on the through track outside the shop



A view in the opposite direction showing the monorail switch into the shop in the halfway position

necessitating the movement of wheels or axles from one point to another.

Machine Tool Arrangement

The shop building is divided longitudinally into three bays, a north and south bay each 30 ft. wide and a center bay 15 ft. wide, all 200 ft. long. In the north bay there are two doors, one in the north wall approximately 50 ft. from the west end of the shop and one at the east end of the bay. The heavy machinery is located in this bay. Along the north wall there is a Niles 300-ton single-end demounting press to the left of the door and, to the right, a 36-in. Norton car wheel grinder. Toward the east end of the bay, from this point, there are, respectively, two Sellers 42-in. car-wheel lathes, a Niles 250-ton double-end mounting press and, at the northeast corner, a Niles 36-in. car-wheel boring mill.

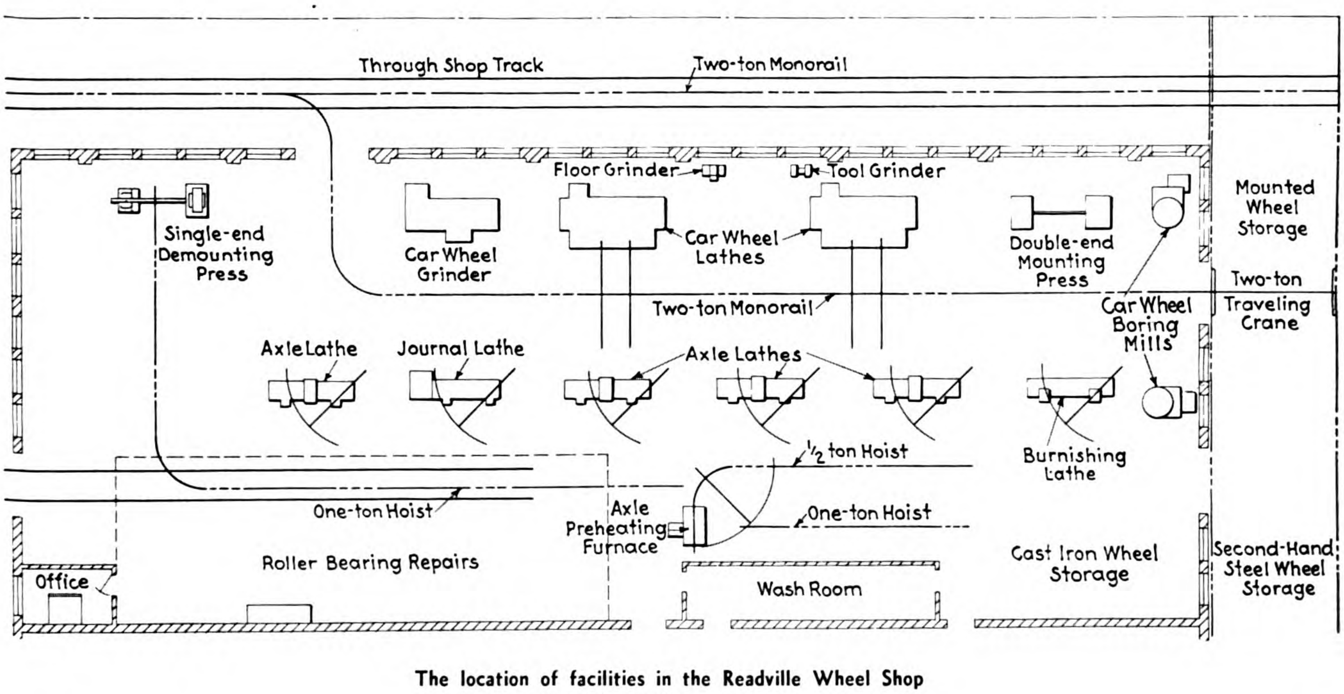
In the center bay, from west to east, in order, are a Putnam axle lathe, a Putnam journal lathe, three Putnam axle lathes, a Putnam journal burnishing lathe and a Putnam 36-in. car-wheel boring mill.

The south bay has outside doors at both ends of the building. The west half of the bay has been set aside for the servicing of roller bearings and most of the east end of this bay is used for the storage of cast-iron wheels. At the center, adjacent to a wash and locker room, is a furnace used for preheating axles preparatory to building up worn collars by welding.

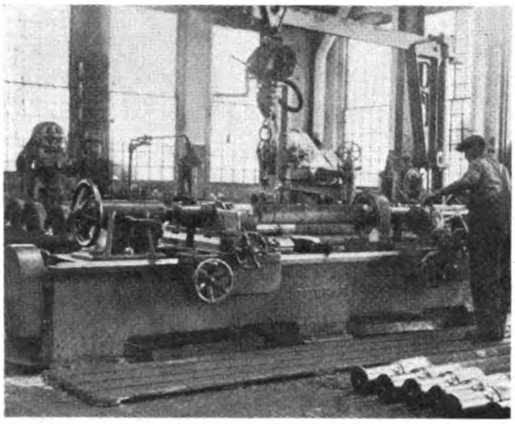
With the exception of the hydraulic mounting and demounting presses all of the machine-tool equipment of this shop has been in service less than 10 years.

Shipment and Inspection of Wheels

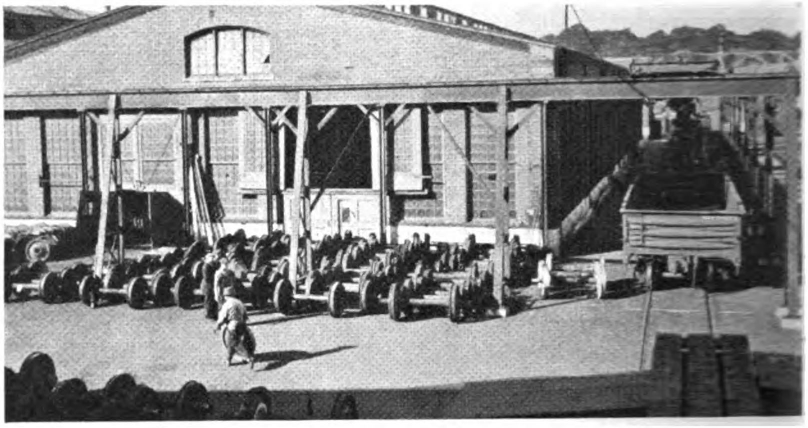
When a pair of wheels is removed from a car at any point on the New Haven because of a defect the inspector or foreman responsible for its removal attaches a tag to the axle. One of these tags is shown in an illustration. Upon the tag is recorded the identifying data, dimensions and a symbol which indicates the defect which caused its removal from service. A form, also shown, is filled out at the point of removal. This form shows the symbols indicative of wheel and axle defects as well as the wheel



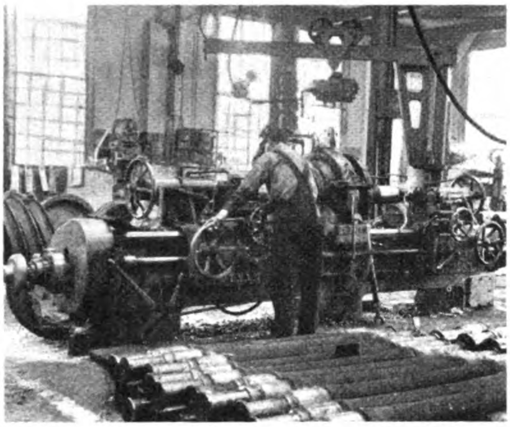
The location of facilities in the Readville Wheel Shop



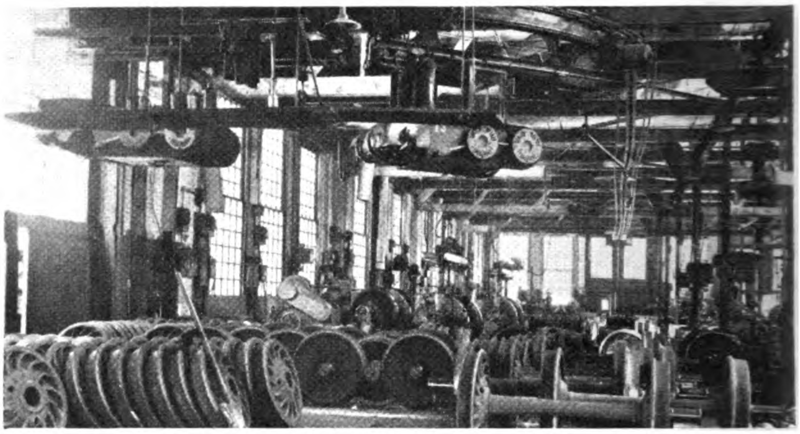
The burnishing lathe



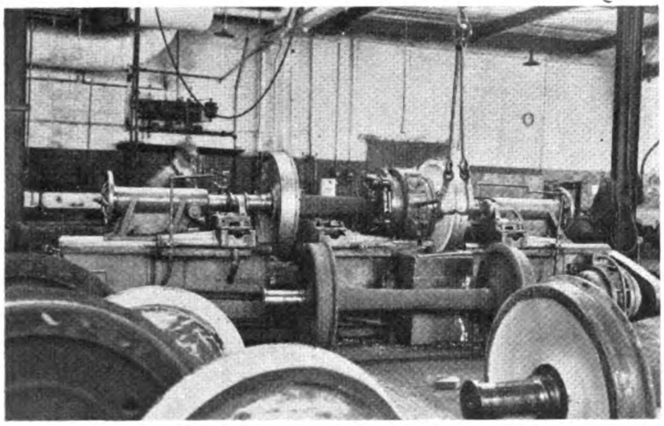
The east end of the shop



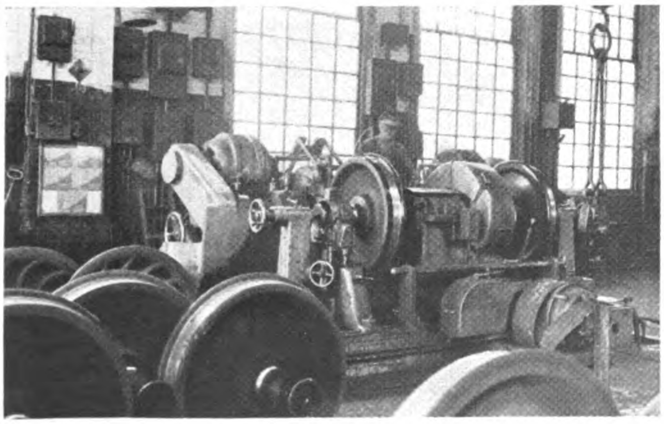
One of the axle lathes



The heavy machinery bay



A journal lathe in operation



Car wheels are ground here

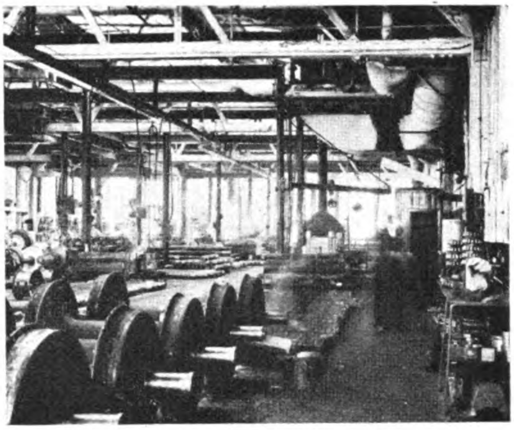
records such as serial numbers and the number and initials of the car from which removed. Five copies of this form are filled out at the shipping point, three of which are sent to the wheel shop, one retained by the shipper and one sent to the auditor of disbursements. After the wheels are received at the wheel shop and inspected the additional data is filled in on the three copies and two copies are sent out by the wheel-shop foreman—one to the stores department and one to the auditor of disbursements. From the two copies received by the auditor of disbursements—one from the shipper and one from the wheel shop—the correct billing repair cards are made out.

When defective wheels or axles, are received at the wheel shop they are first carefully inspected by the wheel-shop inspector who uses standard A.A.R. gages to determine whether or not the shipping tag accompanying the wheels is correctly filled out as to defects and dimensions as well as to determine whether there may be additional defects not discovered by the inspector who caused the wheels to be removed. The wheel-shop inspector's report not only serves as the basis of determining the nature of the repairs needed but also to record the actual condition and dimensions of incoming wheels and axles so that a comparison of the inbound shop inspector's report and the report when the wheels leave the shop will provide an accurate picture of what happened to the wheels while they were passing through the shop. By these records the service life and performance of wheels and axles may be watched and failures in service due to unsatisfactory workmanship reduced to a minimum.

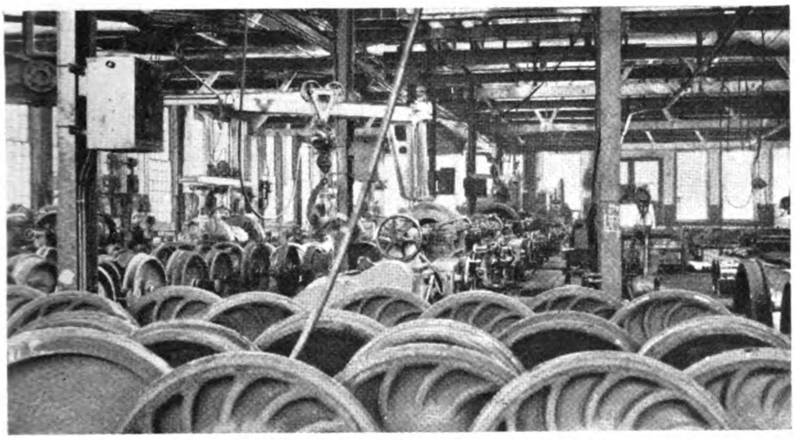
Analysis of Operations

The wheels and axles which come to the Readville

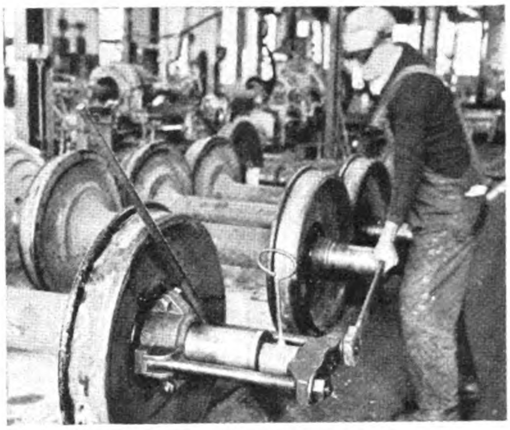
Looking north along the midway



Roller bearing repair section



The center bay looking east



Pulling a roller bearing

Shop for repair and the work which is performed upon them may be segregated into four general groups:

GROUP A—CAST-IRON WHEELS

1—Serviceable axles with condemned wheels.
2—Condemned axles with serviceable wheels.
3—One wheel condemned; the other serviceable; axle O.K.
4—Axles serviceable with wheel treads to be reground.
5—Wheels serviceable with journals to be re-turned.
6—Boring of new or second-hand cast iron wheels.

GROUP B—STEEL WHEELS

1—Serviceable axles with condemned wheels.
2—Condemned axles with wheels serviceable.
3—One wheel condemned; the other is serviceable; axle O.K.
4—Wheel treads to be re-turned.
5—Wheel treads to be reground.
6—Journals to be re-turned (mounted wheels).
7—Boring new or second-hand steel wheels.

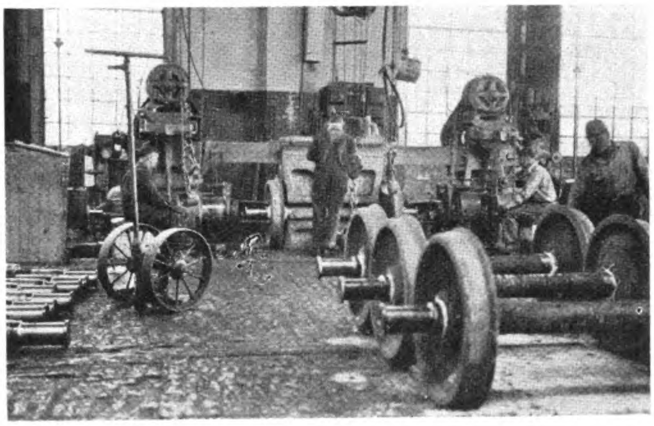
GROUP C—AXLES

New and second-hand axles (without wheels).

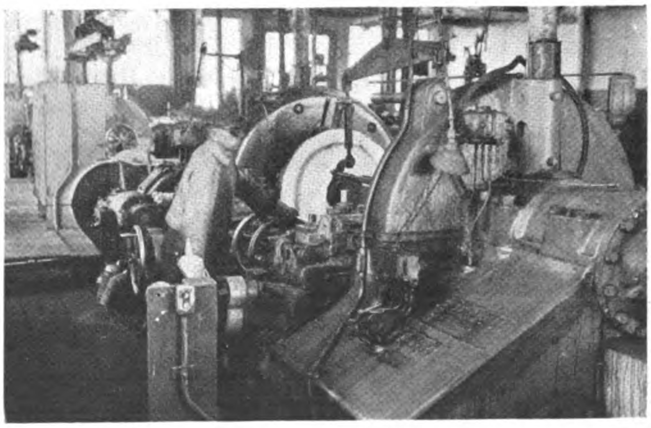
GROUP D—WHEELS WITH ROLLER BEARINGS

1—Wheels condemned.
2—Axles condemned.
3—Treads to be re-turned or reground.
4—Wheels and axles O. K.; roller-bearing repairs.

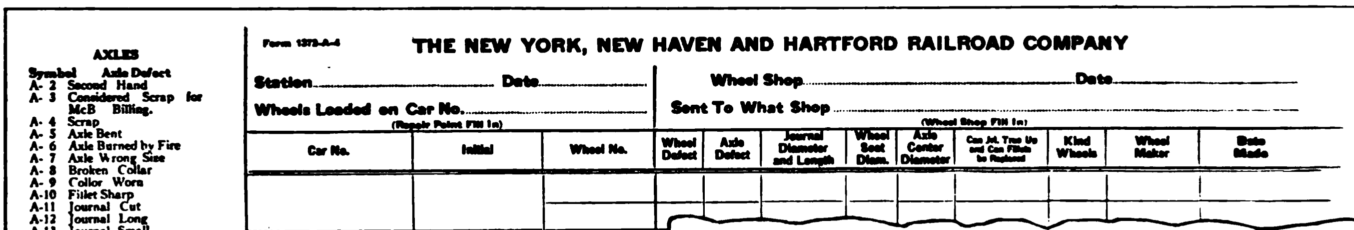
The above items in the four groups represent the most common conditions affecting wheels removed from service and sent to the shop. When they arrive at the shop they pass through various movements and operations depending upon the nature of the defects or repairs needed. These movements have been tabulated in



The double end mounting press



One of the two car wheel lathes

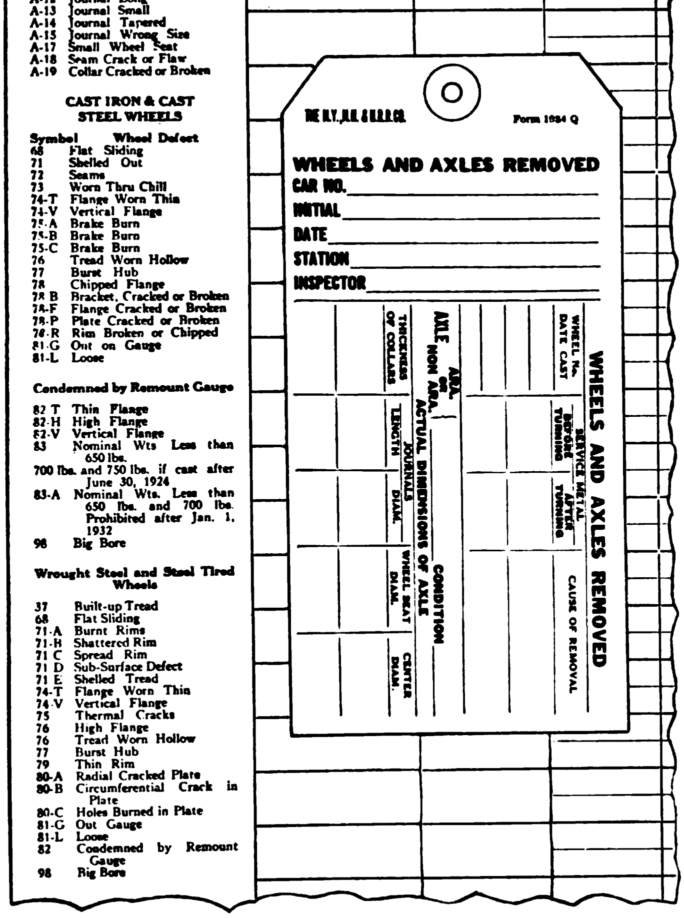


Form 1373-A-4 THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD COMPANY

Station .... Date .... Wheel Shop .... Date ....

Wheels Loaded on Car No. .... (Repair Point Fill In) Sent To What Shop .... (Wheel Shop Fill In)

Car No.	Initial	Wheel No.	Wheel Defect	Axle Defect	Journal Diameter and Length	Wheel Seat Diam.	Axle Center Diameter	Can Jnl. True Up and Can Fillets be Replaced	Kind Wheels	Wheel Maker	Date Made



AXLES

Symbol	Axle Defect
A- 2	Second Hand
A- 3	Considered Scrap for McB Billing.
A- 4	Scrap
A- 5	Axle Bent
A- 6	Axle Burned by Fire
A- 7	Axle Wrong Size
A- 8	Broken Collar
A- 9	Collor Worn
A-10	Fillet Sharp
A-11	Journal Cut
A-12	Journal Long
A-13	Journal Small
A-14	Journal Tapered
A-15	Journal Wrong Size
A-17	Small Wheel Seat
A-18	Seam Crack or Flaw
A-19	Collar Cracked or Broken

CAST IRON & CAST STEEL WHEELS

Symbol	Wheel Defect
68	Flat Sliding
71	Shelled Out
72	Seams
73	Worn Thru Chill
74-T	Flange Worn Thin
74-V	Vertical Flange
75-A	Brake Burn
75-B	Brake Burn
75-C	Brake Burn
76	Tread Worn Hollow
77	Burst Hub
78	Chipped Flange
78 B	Bracket, Cracked or Broken
78-F	Flange Cracked or Broken
78-P	Plate Cracked or Broken
78-R	Rim Broken or Chipped
81-G	Out on Gauge
81-L	Loose

Condemned by Remount Gauge

82 T	Thin Flange
82-H	High Flange
82-V	Vertical Flange
83	Nominal Wts Less than 650 lbs. 700 lbs. and 750 lbs. if cast after June 30, 1924
83-A	Nominal Wts. Less than 650 lbs. and 700 lbs. Prohibited after Jan. 1, 1932
98	Big Bore

Wrought Steel and Steel Tired Wheels

37	Built-up Tread
68	Flat Sliding
71-A	Burnt Rims
71-B	Shattered Rim
71 C	Spread Rim
71 D	Sub-Surface Defect
71 E	Shelled Tread
74-T	Flange Worn Thin
74-V	Vertical Flange
75	Thermal Cracks
76	High Flange
76	Tread Worn Hollow
77	Burst Hub
79	Thin Rim
80-A	Radial Cracked Plate
80-B	Circumferential Crack in Plate
80-C	Holes Burned in Plate
81-G	Out Gauge
81-L	Loose
82	Condemned by Remount Gauge
98	Big Bore

THE N.Y., N.H. & H.R.R. CO. Form 1034 Q

WHEELS AND AXLES REMOVED

CAR NO. ________

INITIAL ________

DATE ________

STATION ________

INSPECTOR ________

WHEELS AND AXLES REMOVED

WHEEL No. DATE CAST

SERVICE METAL BEFORE TURNING AFTER TURNING

CAUSE OF REMOVAL

AXLE A.R.A. OR NON A.R.A.

CONDITION

ACTUAL DIMENSIONS OF AXLE

THICKNESS OF COLLARS

JOURNALS LENGTH DIAM.

WHEEL SEAT DIAM.

CENTER DIAM.

Two forms used in connection with wheel work, the larger being a shopping record of wheels sent to shop and the tag, indicating the defects, which is attached to the axle

A study of Table I will show that the work of the shop consists of handling (a) wheels and axle, mounted; (b) wheels, unmounted and (c) axles, unmounted.

Mounted wheels come in for re-turning or regrinding the treads or to have the journals re-turned and burnished. Wheels such as these are picked up from the car, after inspection and checking, and transported either to the wheel grinder, wheel lathe or journal lathe by one of the monorail travelers and, when completed, are taken out the other end of the shop and loaded on a car for shipment. Wheels requiring demounting are delivered by the crane at the demounting press. The demounted cast-iron wheels go either to second-hand storage or to scrap. In either case they are handled by the crane—to a car on the service track spotted for scrap loading or to the southeast corner of the shop. The axles, if they require re-turning to true up journals or wheel seats are delivered by the crane to one of the

Table I—Movements of Wheels and Axles Through Shop

Group	Hyd. Press	Wheels 1	Wheels 2	Axle
A-1	Demount	Scrap	Scrap	To axle lathe or burnishing lathe
A-2	Demount	To second-hand storage or boring mill, as required.		Scrap
A-3	Demount	Scrap	Same as under A-2	To axle lathe or burnishing lathe
A-4	......	To Norton Grinder		(with wheels)
A-5	......	With axle)		To journal lathe
A-6	......	Storage to Boring Mill		....
B-1	Demount	Scrap	Scrap	To axle lathe or burnishing lathe
B-2	Demount	To second-hand storage or boring mill, as required.		Scrap
B-3	Demount	Scrap one wheel and send other to storage		To axle lathe or burnishing lathe
B-4	......	To wheel lathe		(with wheels)
B-5	......	To Norton Grinder		(with wheels)
B-6	......	With axle		To journal lathe
B-7	......	Storage to Boring Mill		....
C	......	....	....	Axle lathe to burnishing lathe to storage
D-1	Demount	Scrap	Scrap	To roller bearing department.
D-2	Demount	Storage	Storage	Scrap
D-3	......	To wheel lathe or grinder		(with wheels)
D-4	......	(Delivered direct to roller-bearing dept.)		....

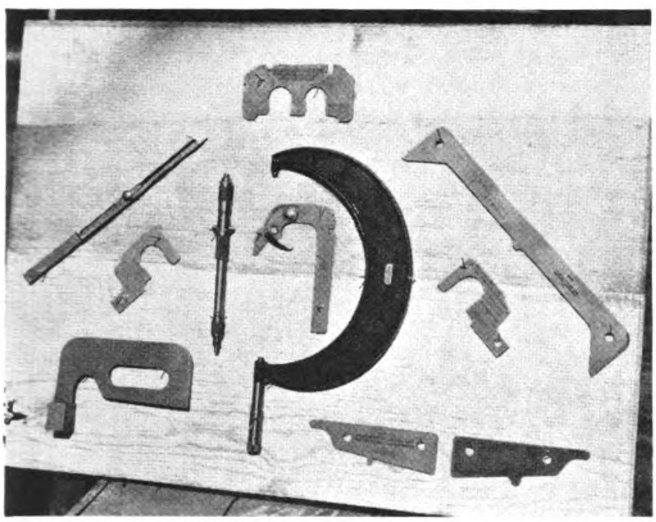
Table I which is an analysis of each of the several conditions outlined in Groups A to D. For example in Group A the first condition (designated A-1) is that of a case where a pair of wheels is received at the shop with a serviceable axle and both wheels condemned. Reference to A-1 in Table I will indicate that the wheels are pressed off from the axle, the wheels sent to the scrap pile and the axle sent either to the axle lathe for re-turning or to the burnishing lathe for rerolling. Likewise each reference, such as A-2, B-3, C, and D-4, in Table I refers to a like numbered condition under Groups A to D.

Table II—Readville Wheel Shop Production

	1	2	3	4	5	6	7
Cast-iron wheels bored (new) / Cast-iron wheels bored (second-hand)	1,158	962	1,546	1,796	1,120	1,204	1,702
Steel wheels bored (new) / Steel wheels bored (second hand)	207	284	168	163	249	116	345
Axles machined (new)—Turned and burnished / Axles machined (second-hand)— Wheel seats and journals turned, journals burnished	786	476	894	999	741	778	1,241
Mounted cast-iron wheels, treads ground, pairs	49	38	41	39	15	28	107
Mounted steel wheels, treads turned, pairs	207	237	277	260	244	258	372
Mounted steel wheels, treads ground, pairs	20	81	62	34	18	9	54
Cast-iron wheels demounted, pairs	662	775	819	929	803	821	1,159
Steel wheels demounted, pairs	212	113	209	307	142	93	199
Cast-iron wheels, mounted, pairs	574	538	767	954	596	660	858
Steel wheels mounted, pairs	98	146	73	85	87	110	170
Journals turned and burnished on mounted wheels, pairs	217	225	257	281	167	145	428
Roller bearing wheels serviced, pairs	31	56	44	51	27	18	33
Eight-hour days worked	25	20	24	26	22	21	25
Average number of men in wheel shop during month	20	20	20	20	20	20	20
Average number of pairs of wheels turned out of shop per day	39	52	55	56	44	50	63.8

four axle lathes, thence to the burnishing lathe to have the journals rolled and finally are placed in a pile adjacent to the burnishing lathe where the boring mill men "mike" the wheel seats and mark the axle so that the mounting-press operators may select the proper wheels (similarly marked) for mounting. All second-hand axles, whether they require truing or not, are burnished before being returned to service. New axles are worked through the shop as required.

In the case of unmounted steel wheels the second-hand wheels are transported from the demounting press to second-hand storage and the condemned wheels to the scrap car. The boring-mill operators draw from the new or second-hand steel or cast-iron wheel storage for wheels to bore for mounting. Wheels are mated by tape size and are bored to dimensions taken from the axle on which they are to be mounted. The boring-mill operator measures both wheel seats on the axle and places a different chalk-marked number on each wheel seat. A wheel is then bored to fit each wheel and the wheel carries a number corresponding to that marked on the wheel seat by the operator. The tolerances and mounting pressures recommended by the latest A. A. R. Wheel and Axle Manual are adhered to. After mounting, the wheels are checked by an inspector before shipment and the wheelshop record previously mentioned is completed.



A set of standard gages and micrometers used in wheel work—Among the gages shown are: the A. A. R. standard wheel gage, worn-through chill gage, wheel contour gage, journal fillet gage, tread worn-hollow gages and remount gages for cast-iron and steel wheels

Shop Production

Some idea of the productive capacity of the machine tool units in the shop may be gained from the following list giving the output from one machine, in each case, in an eight-hour day:

Steel wheels turned	9 pairs
Axles turned	16
Journals trued on mounted wheels	12 pairs
Journals rolled	35 pairs (35 axles)
Cast-iron wheels bored	66
Wheels mounted	55 pairs

In addition Table II shows the production record of the Readville for seven months, six of which were consecutive months during 1935 which were typical of the operation under then existing conditions and the seventh month one of nearly maximum potential output without material addition to the force.

Are Interchange Rules 68 and 84 Fair?

By H. A. McConville*

The intent of the A.A.R. code of interchange rules, covering repairs, inspection, etc., of freight and passenger cars, is presumed to be fair and equitable to all concerned. With this thought in mind, we find the various committees of the association, from year to year, modifying the rules to meet changing conditions, rectifying any apparent irregularities or unfairness. To my mind there still remain in this code two rules that, being interpreted as they now are as handling-line responsibility, are manifestly unfair to the railroads. I refer to Rule 68, which covers slid flat wheels, and Rule 84, pertaining to cut journals.

In propounding controversial questions of this nature, the proponent should be in position to sustain his contentions with basic facts, hence I submit the following factual statements.

Rule 68—Slid Flat Wheels. There are three attributable conditions, which are mainly responsible for sliding wheels under cars. First, inoperative air brakes, due solely to some mechanical defect in the brake mechanism. Second, improperly proportioned or adjusted brake rigging. Third, moving cars with hand brakes set up too tightly.

Of these three conditions, inoperative air brake mechanism is by far the predominating factor in producing slid flat wheels. Fortunately, due to improved shop practices and inspection requirements, slid flat wheels as the result of the second mentioned cause are almost nil. The final factor—operating cars with hand brakes set—no doubt accounts for numerous slid flat wheels, especially in hump yards, mountainous country and other abnormal track conditions.

Since the first two mentioned factors are always considered owner's responsibility, and the rectification thereof is properly chargeable to car owners, any resultant damages from these conditions should likewise be chargeable to the car owners. Hence, in fairness to all concerned, Rule 68 should be modified to read: "Charges for renewal of wheels account of slid flat, when accompanied by charges for repairs to air brakes or brake rigging, will be rendered against car owner; slid flat wheels under any other conditions will be considered delivering line responsibility."

Rule 84—Cut Journals. This defect is invariably the result of some defective condition in the journal, journal brass, or other contained part of journal boxes or trucks, or of inferior packing. Repairs to any of these, separately or collectively, are properly chargeable to the car owner, except when associated with derailment, accident or when the journal is cut. The parts that most vitally affect the lubrication of the journals are more or less concealed from view, and the repacking date as stencilled on the car, and for which the car owner is responsible, is a literal guarantee that the condition of all journals and contained parts is good. Hence car inspectors are only required to give these parts the customary casual inspection in train yards and on interchange tracks. Contributing factors that might be in an embryonic stage of development of hot box trouble would not be obvious at the time of inspection, but may later develop a cut journal. As the rules do not require a general inspection of journals and contained parts within the prescribed time limit specified in Rule 66, I would suggest that rule 84 be modified to read: "Car owners will be

* Chief car inspector, Louisville & Nashville, Montgomery, Ala.

responsible for cut journals on their cars, except when caused by derailment."

I reiterate my statement that these rules as now in effect are unfair to the railroads. I say this because the railroads must assume the responsibility for these two defects on all cars in transit on their lines, regardless of the length of time such cars have been in their possession. You may readily appreciate the magnitude of this responsibility, when you consider that there are nearly half a million private line cars operating on the rails of the railroad companies of this country, the owners of which assume no responsibility, notwithstanding that many of them may have inadequate, incompetent or no repair or inspection forces.

With this in mind you may conceive the staggering amount of unfair maintenance costs imposed on the railroads by these two rules.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Temporary Repairs, Substitution of a Different Type of Truck Bolster

A St. Louis & O'Fallon car was shopped by the Peoria & Pekin Union on account of a broken cast-steel truck bolster. A Simplex structural steel bolster was applied and bill rendered against the owner in accordance with Item 188-B of Rule 101, in effect during 1934. P. & P. U. defect card was attached to car for labor only, for correcting the wrong repairs. The St. Louis & O'Fallon took exceptions to the charge rendered for material, contending that the Simplex truck bolster applied constituted temporary repairs only, and requested additional defect card to cover wrong material. This was declined by the P. & P. U. The St. Louis & O'Fallon contended that the third paragraph of Rule 87 applies for the reason that the repairs made were of a temporary nature only.

The improper truck bolster was removed and a bolster standard to the car applied, the car being considered unsafe to handle with bolster applied by P. & P. U. for following reasons (based on the facts set forth in the joint evidence statement submitted):

A—Excess column guide clearance permitted a side movement of car body of approximately 3¼ in. This would cause coupler to be out alignment and did not permit proper coupling to other cars.

B—The excess height of side bearing eliminates side-bearing clearance.

C—The oversized centerplate permits the car body to shift approximately ¾ in. in any direction and places undue strain on the center pin.

D—The slight difference in depth of center plates, prohibits body-bolster center plate from proper contact with the bottom center plate.

E—The ⅜-in. boss around the center-pin hole in truck bolster makes it impossible for body center plate to have proper bearing surface. It rides the collar or boss of bottom center plate, and does not have full bearing surface of a center plate with a flat bearing surface.

F—Elimination of rollers from Simplex bolster provides an unsatisfactory bearing surface.

In addition Simplex truck bolster measures 8 ft. 1 in. overall length while standard bolster measures 7 ft. 6 in.

The Peoria & Pekin Union contended that while the Simplex bolster was slightly longer than the cast-steel bolster removed, the center plate was an A.R.A. standard having a 12-in. bowl with 1¼-in. flange that it was used to expedite movement of this loaded car, that the work was performed in a workmanlike manner and that the car carried its load to destination and later returned home empty and that the bolster could have continued its service indefinitely had not the owner desired to remove it and apply a standard bolster. This road considered that it had complied with the requirements of Rule 88. utilizing its stock material to expedite the movement of a loaded car, and applied a defect card covering "Labor Only" for correcting wrong repairs.

In a decision rendered April 11, 1935, the Arbitration Committee said: "The evidence in this case indicates the bolster applied was unsuitable for permanent use under the car in question and can only be considered as temporary repairs. The contention of the St. Louis & O'Fallon Railway is sustained."—*Case 1745, Rule 87, St. Louis & O'Fallon vs. Peoria & Pekin Union.*

Charge for Application of Brake Beam Safety Guard Rivets

The Denver & Rio Grande Western charged the Kansas City Southern for labor of removing spring planks in order to apply brake-beam safety guard rivets, and K. C. S. objected to the labor of removing the spring planks, claiming that this was unnecessary. The K. C. S. stated that, by properly jacking the truck it was possible to apply these rivets without removing the spring plank as there is sufficient clearance for the rivets to be driven. The K. C. S. claimed it did not receive similar charges from other lines on this same equipment. The D. & R. G. W. contended that rivets could not be properly applied to cars of the construction of those owned by K. C. S. without either removing the spring planks, placing the car over a pit or securing the trucks to the car body and jacking the entire car, including the trucks, high enough to permit the operation of an air hammer from underneath the spring plank. It maintained that Item 98, Rule 107, applies only to jacking a car for removal of the truck or to secure sufficient space between the truck and the car body to make the repairs mentioned in Item 99, Rule 107, and that when necessary to remove any part of the car, not secured with rivets but necessary to apply rivets, Item 307 will apply and that repairing companies are not required to jack and block the trucks after removal from the car, in order to apply rivets, but instead may remove the part and charge the labor specified in Rule 107.

In a decision rendered April 11, 1935, the Arbitration Committee said: "It is common practice to R. & R. rivets referred to without removing spring plank from truck and charge should be so confined. The total labor for jacking, however, should not exceed one hour per end of car in cases where jacking is necessary. The contention of the K. C. S. is sustained.—*Case No. 1746, Rule 107, Kansas City Southern vs. Denver & Rio Grande Western.*

IN THE BACK SHOP AND ENGINEHOUSE

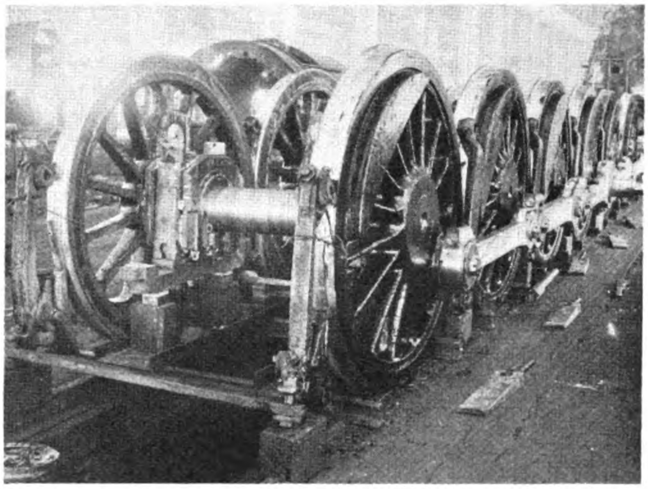
Omaha Locomotive Shop Kinks

Among numerous effective labor-saving methods used at the Union Pacific locomotive shops, Omaha, Nebr., special mention may be made of the practice followed in wheeling locomotives. This consists, as shown in the illustrations, of assembling the driving wheels, rods, binders, shoes and wedges, brake beams, hangers, etc., in place so that after the locomotive is wheeled, the subsequent finishing operations can be performed easily and in a very short time.

While this idea in the wheeling of locomotives is by no means new, it differs in a number of important particulars from the practice followed on most other roads. In the first place, the wheels shown are for a Union Pacific 9000-class, 4-12-2 type locomotive, the only locomotive with 12 coupled driving wheels used in this country up to the present time. The locomotive has three cylinders, the inside one being connected through a suitable piston, crosshead and main rod design to the inside crank axle of the No. 2 pair of wheels. The counter-weights on this crank axle and also the front end of the inside main rod are shown in one of the illustrations. Obviously it is much easier to apply this inside main rod to the crank axle before, rather than after, wheeling the locomotive.

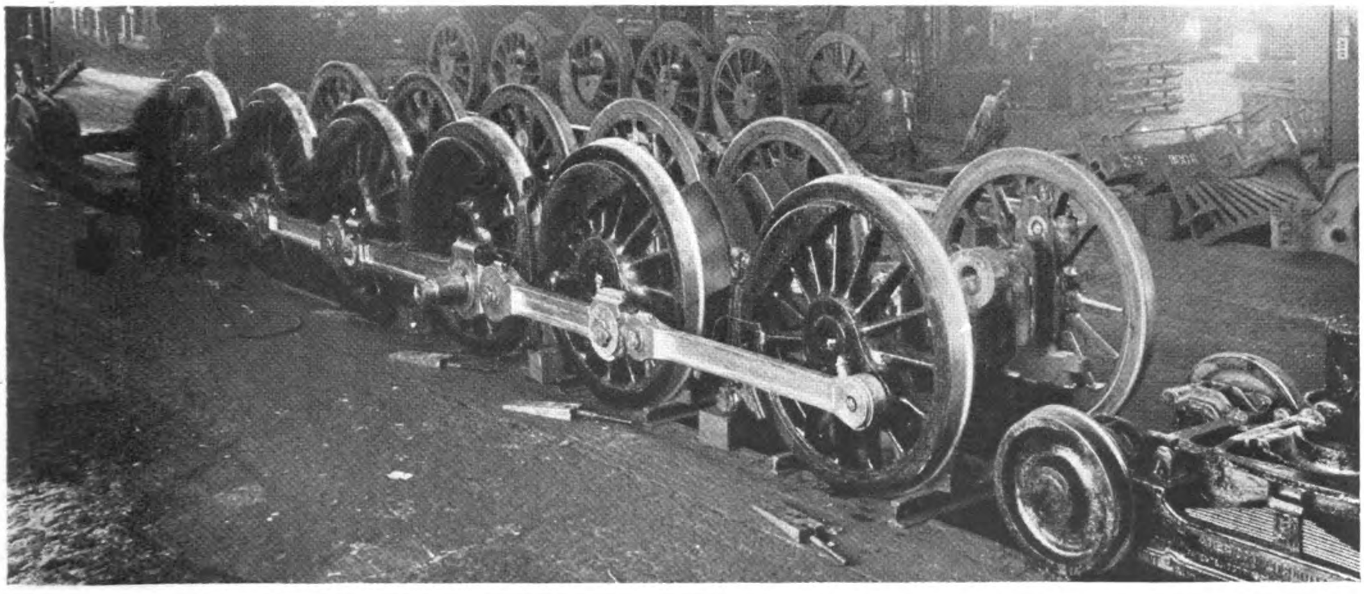
The general practice in wheeling locomotives by this method is to set the reconditioned driving wheels and boxes on the wheeling pit track, tram the wheel centers, apply the side rods as a coupled unit by means of a special chain suspension from the traveling crane and apply the inside main rod. A cross rail is applied in front of and one back of each pair of wheels, and a 15-in. channel, 56 in. long is placed across these rails under each driving box. On each channel is placed two 6-in. by 8-in. wood blocks, 12 in. high, with smaller wood-shim blocks on top, to support the binder at the proper height, in other words just touching the bottom of the driving box. The shoes and wedges are assembled in place and held in the driving box shoe-and-wedge ways by small wooden wedges. The brake beams and hangers also are assembled in place, being supported on wood blocks, and the upper ends of the hangers are tied against the driving wheels.

The front and back trucks are then set in place and the locomotive brought down the shop and spotted over the wheels, using the shop crane. The application of the inside main rod before wheeling introduces a slight



How the binders and brake rigging are blocked up ready for wheeling

complication in that the rod operates through a frame crosstie and guide yoke, and consequently the front end of the main rod must be raised and inserted through this guide yoke as the locomotive is lowered. This is accomplished by means of a chain-falls, suspended from the barrel of the boiler and used to keep the rod end at



The driving wheels and trucks of a U. P. 9000-class locomotive—Rods are applied before wheeling

the proper height as the locomotive is being lowered.

One of the great advantages of this method of wheeling is substantially reduced work in applying binders. The locomotive is lowered until the frame pedestal toes are forced down into the binder fit under sufficient pressure to spring the supporting cross channels slightly. The binder nuts are then easily applied and tightened and the binders are nearly up. The locomotive, after being raised slightly to remove all blocking, is then lowered until its weight rests on the driving-box spring saddles and the front and back trucks, Final driving up of the binders, tightening the binder nuts, applying brake rods, etc., is then an easy matter.

Setting Eccentric Cranks

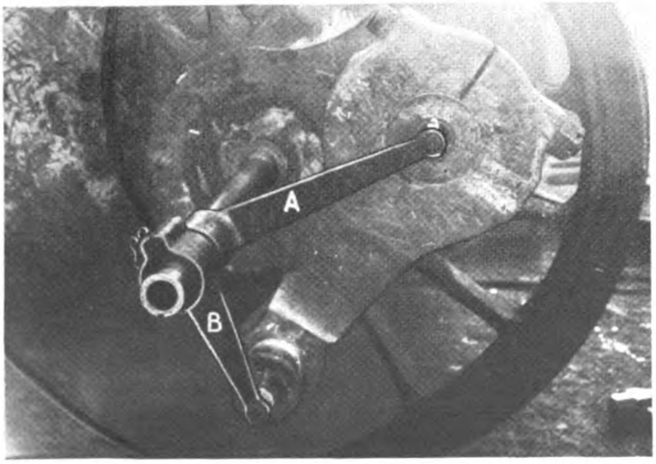
A quick and accurate method of setting the eccentric cranks on driving wheels having hollow-bored axles is shown in the illustration. The particular wheels indicated are the main wheels for a Union Pacific 9000-Class locomotive, and being of the three-cylinder design, this locomotive has three cranks set 120 deg. apart. This same jig with a slight modification can however be used in setting the eccentric cranks on the conventional two-cylinder locomotive having the crank pins 90 deg. apart.

The jig consists of a 2½-in. steel shaft, 132 in. long, which extends all the way through the hollow axle, with an extension a little less than 3 ft. long on each side to accommodate sliding arms for checking the crank arm position. The main shaft is centered in the axle bore by means of two threaded cones, one of which is usually held stationary and the other drawn toward it by turning with a spanner wrench. This centers the shaft accurately in the axle bore. The inside arm *A* is an accurate sliding fit on the shaft. It is held in a fixed angular position by means of a sliding key and keyway and has a scribing point at the outer end just 16 in. from the shaft center line. This arm, in conjunction with a similar arm on the other crank pin, gives an accurate check of wheel "quarter" and stroke.

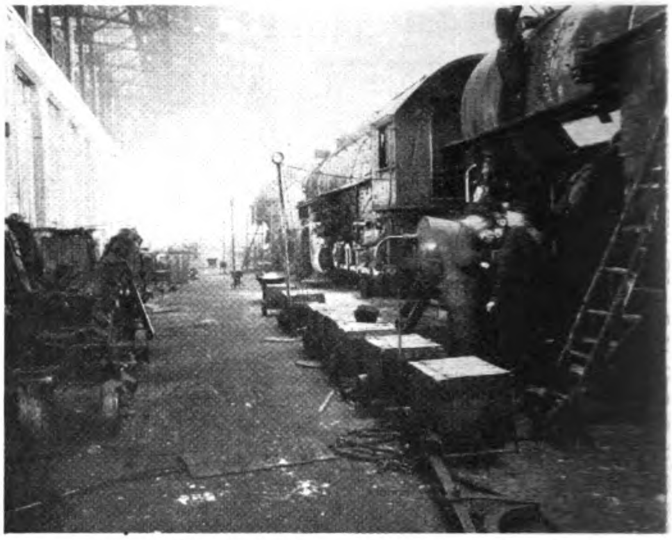
Similarly, arm *B* is an accurate sliding fit on the shaft but without any keyway connection. The distance from the shaft center line to the outer scribing point of arm *B* gives the standard "throw" of the eccentric, and also assures the correct angular relations, since the eccentric crank is made to standard length.

Applying Driving-Wheel Tires

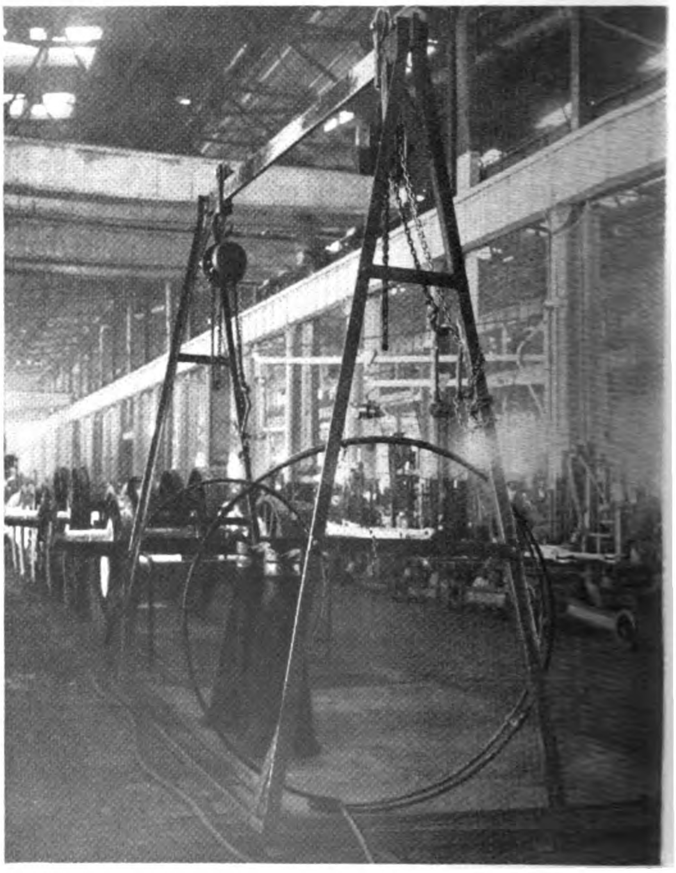
A double A-frame and equipment used in applying driving-wheel tires is shown in another illustration. The wheel centers mounted on the axle are held at the

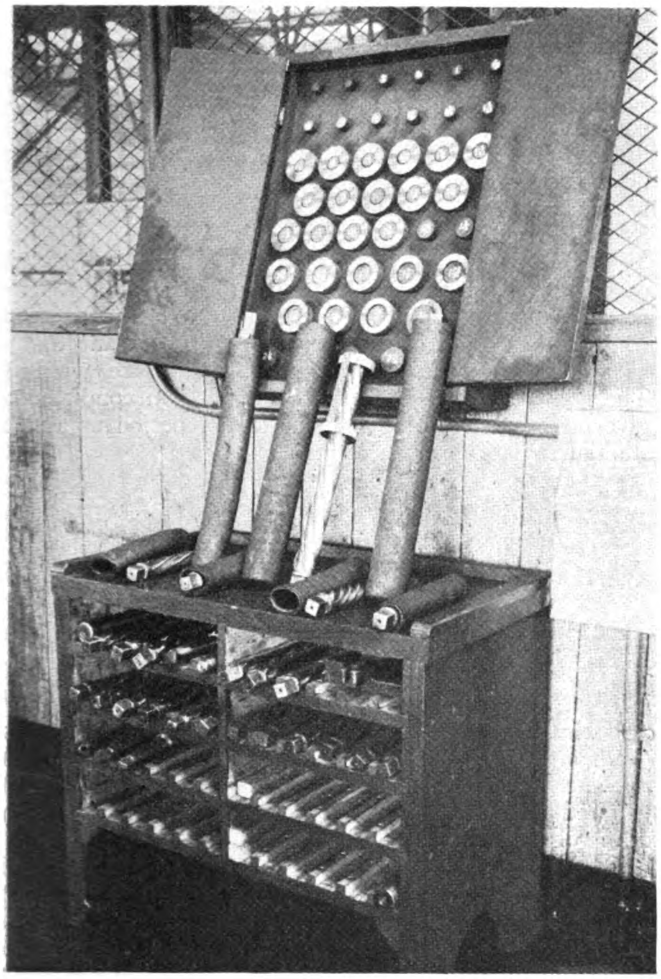


Eccentric checking gage as used with main driving wheels having hollow-bored axles


A clear passage way is maintained through the erecting shop—Electric-light extension cords are carried overhead

proper elevation by means of two taper plate metal supports, the upper ends of which are equipped with V-castings to hold the axle. The double A-frame is built up of an angle-section framework suitably braced at the bottom and tied together at the top by a wide steel plate which serves as a runway for two flanged wheels and hooks designed to support chain falls which in turn are used to hold the tires at approximately the same elevation as the wheel centers. The usual heater rings, shown in the illustration, are applied over the tires which are then heated and expanded enough so that it is a relatively easy matter to apply them over the wheel cen-


Double A-frame and equipment used in shrinking on locomotive driver tires



Pratt & Whitney ring gages used in checking reamer size and taper at Omaha shops—Reamers are protected in boots

ters by proper adjustment of the chain falls and a few light hammer blows.

Keeping Erecting Shop Passageways Clear

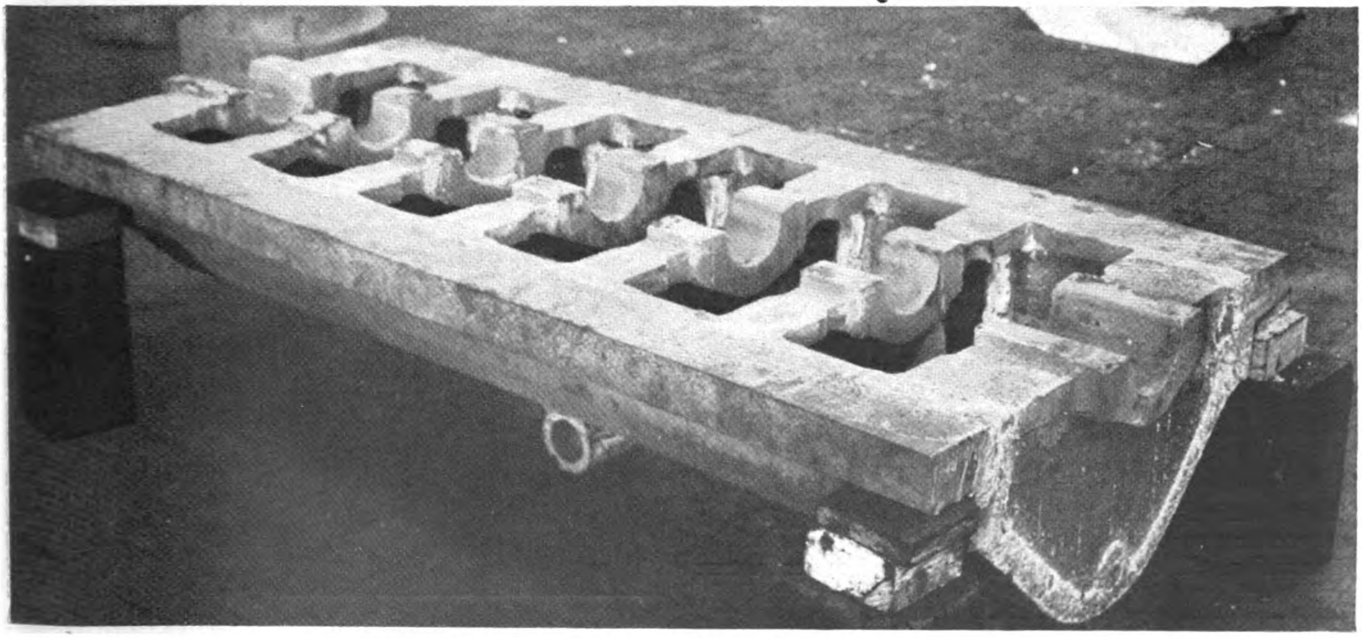
Another illustration shows how a clear passageway is maintained at all times past the often-congested finishing track in the erecting shop. After locomotives have been wheeled and the scheduled out-of-shop time is only a few hours away, it is often necessary to concentrate quite a number of machinists, pipe fitters, jacket men and cab fitters on a single locomotive, to such an extent that repair materials, tool boxes, electric-light extensions, air hose connections, etc., more or less block the passageway by the locomotive and interfere with the movement of men and materials to other parts of the shops.

To overcome this difficulty, a passageway is kept clear at the Omaha shops of the Union Pacific, as illustrated, by lining up tool boxes in a single row where they are convenient to the workmen but leave ample space for the passage of trucks on the outer side. Air hose lines, where necessary, are carried across the passageway under a protective metal sheet. All electric-light extension cords are carried overhead across the passageway by passing them through an eye in the upper end of a 10-ft. length of boiler tube fixed in a circular base plate and provided with an eight-plug outlet box. Both the intake lead from the left to the box and all extensions used from the box to the locomotive pass through the upper eye support which keeps the extensions up high enough so that they will be well out of the way of workmen or trucks passing beneath. With this arrangement, a noticeably increased life of electric-light extension cords has been secured, as compared with permitting the cords to rest on the floor where they are subject to more or less unavoidable wear and abuse.

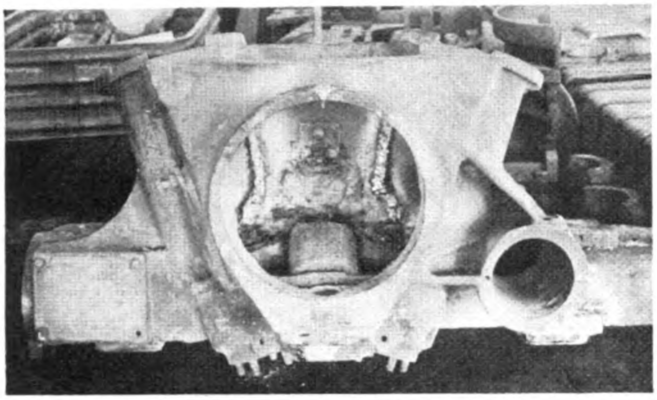
Care of Locomotive Frame Reamers

Locomotive frame reamers are given particular attention in order to make sure that the best results are secured in reaming bolt holes in locomotive frames, cylinders, guide blocks and other parts. A set of high-speed steel reamers, varying from $\frac{5}{16}$ in. to $2\frac{3}{8}$ in. in diameter and from 6 in. to 18 in. in length is maintained in the tool room on the ground floor, being sent to the upstairs tool room, after each use, for checking in order to make sure that they are sharp and in good condition for further service.

All dull reamers are ground on a No. 15 Brown & Sharpe universal tool grinder and Pratt & Whitney rings gages are used to provide an accurate check of the size and taper. These ring gages, made of especially hard-



Rolled and forged steel crank case completely fabricated by electric welding



Stoker hopper having cracks welded and steel elevator bushings and sealing rings applied by bronze welding

ened steel, are finished on the inside with an accurate taper of 1/16 in. per ft. They are provided in 1/32 in. sizes so that if one ring gage is applied over a reamer and the next size smaller gage fits the reamer at a point just 6 in. above the first, the reamer taper is shown to be correct. Incidentally, if the upper gage just fits the end of the reamer it indicates the reamer size at the end which is marked on the reamer shank with an electric etching tool.

These ring gages are quite valuable and to prevent losing them as well as to furnish protection against damage they are kept on circular wooden pegs in a cabinet, as shown in the illustration, with hinged doors which may be closed and locked. Both the gages and the pegs are marked to show the respective sizes. All ring gages are dipped in a lubricating oil once a week or more often, if necessitated by unusually damp weather, to make sure that they are kept free of rust or water marks of any kind.

The rack for holding reamers which are sent to the upper toolroom for inspection and resharpening is shown underneath the ring cabinet. This rack is substantially made of wood, being 3 ft. long by about 18 in. wide and 30 in. high and provided with eight separate compartments for accommodating a total of 48 reamers.

A feature of the reamer handling at Omaha shops is the provision of rubber protective boots, made of scrap air-brake hose, with a circular wooden block secured in one end of each and cut long enough to accommodate the respective reamer lengths. Reamers which have been inspected and resharpened are placed in these boots before being checked out of the toolroom, and rigid instructions are enforced requiring that reamers be kept in these boots at all times while out in the shop except when actually being used for reaming holes. This avoids the bad practice of carelessly placing reamers on the floor or even in tool boxes where the sharp reamer edges are nicked or in other ways dulled, by contact with concrete floors, steel tools or other hard parts. The result of all this precaution is to assure an accurate and keen cutting edge on all reamers used in the shop with consequent notable improvement in both the production of reamed holes, smoothness of the hole finish and accuracy of the bolt fits.

Welded Crankcase-Stoker Hopper

A crankcase for a six-cylinder internal combustion engine, entirely fabricated of forged and rolled steel by the welding process at the Omaha shops, is shown in the illustration. The outside parallel edges of the crankcase consist of two 4½-in. by 4½-in. steel bars, cut 5 ft. long and spaced 26 in. apart on the outer edges. The bottom of the crankcase consists of a ½-in. plate of boiler steel, rolled to the necessary shape and welded to the steel bars. The 4-in. crank-shaft bearings, including both end and intermediate bearings, are steel forgings supported by boiler-plate webbing and suitable end plates, all joined in a single well braced, rigid unit by the electric welding process. The crankcase is preheated before the welding operation and carefully normalized afterwards to relieve, so far as possible, all internal stresses.

A stoker hopper reclaimed by the bronze welding process is also illustrated. Steel bushings, made of rolled boiler plate, are applied in the elevators and new sealing rings in the bottom; also several cracks are repaired, and a broken supporting lug applied by bronze welding. The reclaimed hopper is thereby placed in condition to give effective service for an extensive period at a substantial saving in material and labor costs.

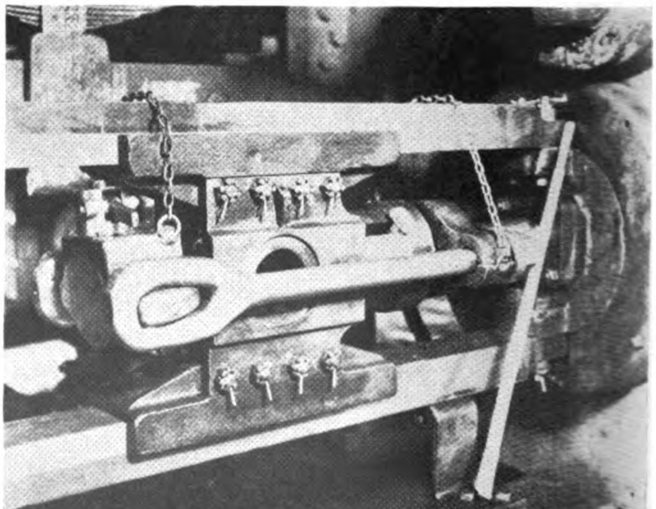
Piston-Rod And Crosshead Jack

By John L. Malone

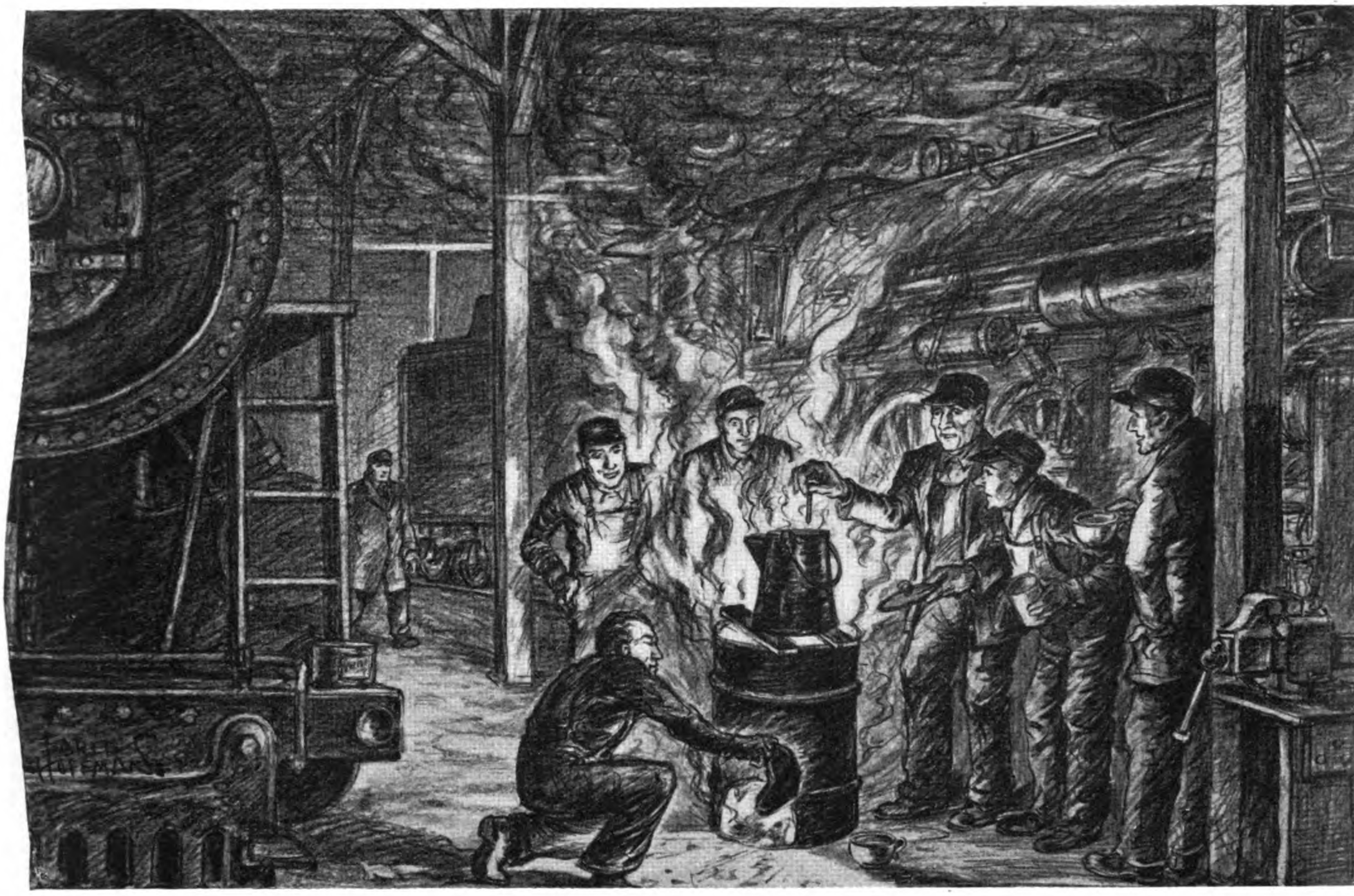
A device that will remove the piston rods from the crossheads on locomotives without injuring the wrist-pin hole in the crosshead is shown in the illustration. It can also be used for general work as it will push or pull, raise or lower, heavy loads.

This portable tool comprises a compact hydraulic jack with a swivel head that operates independently from the ram, so as to permit the use of the lever from any desired angle. The jack itself is hung in place back of the crosshead by means of a chain around the top guide and a suitable space pin is inserted between the jack and the end of the piston rod. A split clamp is then suspended by a chain in front of the piston rod boss of the crosshead and the jack is anchored to it by means of two tie rods. Then, with a few strokes of the lever, oil is pumped from the reservoir into the ram cylinder, forcing the piston rod loose from the crosshead. The operation requires only a few minutes after the jack has been set in place.

This jack, as illustrated, weighs 96 lb. without the tie rods, space pin and clamp, and will develop a pressure in excess of 150 tons.



Jack for parting piston rod from crosshead without injury to wrist-pin hole



If it sinks, the coffee is too weak; if it floats the coffee is just right; but if the nail bounces, why the coffee is just a little strong

The Roundhouse Coffee Pot

by
Walt Wyre

The door-mat in front of the roundhouse office of the S. P. & W. at Plainville is a piece of front-end screen bolted to a frame of two-by-fours laid flat. Not much for looks, but strong and sturdy; that's what it takes in a roundhouse, and that goes for men, too.

If the mat hadn't been strong, Jim Evans, the roundhouse foreman, would have shoved a foot through it trying to shake the mixture of snow and congealed fuel oil off his overshoes. Snow alone is bad enough, but cold fuel oil sticks like a political grafter to the Government payroll.

After considerable stamping and scraping, Evans gave it up as a bad job and went in the office. He removed the soggy overshoes and stood them by the radiator to dry. He sat down in a much-patched office chair that had been thrown away as worn out by the superintendent, chief dispatcher and master mechanic in the order named. Evans slid to a comfortable position on the lower end of his backbone with his feet propped on an open drawer of the desk and took a chew of "horseshoe" to steady his nerves.

It had been a hectic day and the day wasn't yet over. First, it was the 5091—injector failed after the engine was set out ready to go on the Limited—lost thirty minutes. Then the 2870 threw up her tail and quit with a broken main pin fifteen miles out of town on a westbound Red Ball freight. An hour and a half delay wasn't so bad, but they had to send the 375 to take the train and that meant setting out twenty cars so the smaller engine could handle the train. On top of that, the motor car that made the branch line run was in the back shop for overhaul and the 375 was the engine planned for that run next morning. There'd be hell to pay over running a 5000 on the three-car branch line train, but nothing else to do. The 5075 was the only engine left for the Sanford line; every other serviceable engine available was marked up to run on other trains.

Evans settled in a comfortable position. The chew of "horseshoe" going good, he was trying to decide whether to spit or drown when the telephone rang.

John Harris, the clerk, answered it. "Yes, roundhouse clerk talking. . . . Uh-huh . . . O. K. . . .Wait, I'll ask him." Harris placed his hand over the mouthpiece and turned to Evans. "Train delayer wants a 5000 for a CCC train east at eight o'clock."

Jim expectorated a stream of tobacco juice that half filled the cuspidor. "Tell him there ain't no 5000—ain't

no engine at all. Ask him what's coming in on the train," he added.

Harris asked the dispatcher, listened to his reply and again covered the telephone mouthpiece. "Says there won't be no engine, we're getting the train from the Burlington. What'll I tell him?"

"Tell him to have them wood choppers get out and push!" Evans growled. "Aw, hell, tell him the 5075. Guess I'll have to work a gang overtime and get the 5092 off the drop-pit for the Sanford line," he added half to himself.

* * *

The foreman pulled on his steaming overshoes and waded out in the snow. Machinist Johnson and his helper were working on the 5092. The wheels were up and they had started on the rods. The pipe-fitter was working in the cab replacing pipes. Lewis, another machinist, and his helper were working on the 2817, another Class Six engine just stripped. Evans told Lewis and his helper to help on the 5092. He then went in search of Ned Sparks, the electrician, and told him to see what all was needed to get the electrical equipment on the engine ready to go.

"There's no dynamo on her, for one thing. You know we had to rob the one off her for another engine."

"Have you got one ready to go back on her?"

"No, haven't got the part yet. Guess we can get one off the 2817," Sparks told him.

"Well, get it going. Stay with it until it's finished." Evans climbed up in the cab of the 5092 to see how things looked in there. They didn't look so good, steam and air gauges were gone, one water glass was missing —used on other engines for running repairs, the injector had been taken off that morning to replace the one that went bad on the 5091. "Looks like an all night job," Evans mused, as he calculated the time required for the various jobs.

The two machinists and their helpers, a pipe man and helper, and the electrician were told to stay on the job until their work was done. They knocked off at six o'clock for lunch and were back at it.

"How's the coffee?" Johnson asked about nine o'clock.

"I'll see about it," his helper volunteered, and walked over to the "salamander" between the 5092 and the next pit.

In case anyone doesn't know what a salamander is, it is an improvised heater made from an empty oil drum in which coal is burned. The fellow that invented the salamander must have originated the saying, "where there's smoke there's fire," because six feet away from one, that's the only way to tell.

The coffee pot was setting on two pieces of flat iron on top of the salamander. Like the door-mat, the coffee pot was no utensil to grace a model home, but the coppersmith that turned the seams on it by hand was proud of it when he built it. It was made of sixteen-gauge galvanized iron and held between two and three gallons. Before the handle and lid was put on, it looked like a small petticoat pipe before the skirt is put on, broad at the bottom, tapering to the top. An occasional bright spot where solder had melted gleamed along the seams through a heavy coating of velvety black soot from letting the pot boil dry.

The machinist helper hefted the pot and decided there wasn't enough coffee in it. He filled it about two-thirds full with water from the wash-out line and set it back over the fire. He decided the coffee wouldn't be strong enough and dumped in a little over half a pound can of coffee. "Have to get some more coffee tomorrow," he announced when he got back to the 5092.

He yelled at the top of his voice

"Let's have some coffee," Johnson suggested about an hour later. Agreement was unanimous.

Cups were kept on a shelf in the adjoining tool room. They, too, were home-made from tomato cans with the tops cut off and edges turned down to make them smooth. One or two boasted handles.

Lewis set his cup on the ground and filled it with the steaming, black concoction. After blistering his tongue, he set it down to cool.

"How is it?" Sparks asked.

"Hotter'n hell!" the machinist replied.

"Strong enough?" Johnson's helper asked.

"Wait until I get my coffee tester," Johnson replied, feeling in his overall pocket.

"What you mean—coffee tester?" the electrician asked.

"Well, you see," the machinist replied seriously, "I have a tenpenny nail with the point ground sharp. I drop it in the coffee point first. If it sinks, the coffee is too weak; if it floats, the coffee is just right; but if the nail bounces, why the coffee is just a little strong."

"What are we having here—a tea-party?" The master mechanic had come up unobserved.

"Just having a little coffee, Mr. Carter," Machinist Jenkins replied.

"Well, it's no wonder overtime runs up! You men standing around drinking coffee when you're supposed to be working!"

The men all started back towards the drop-pit. The master mechanic stopped them. "Hey, wait a minute. Get rid of that coffee pot. If you don't, you'll all be ganged up drinking coffee again soon as I leave."

One of the helpers removed the pot from the salamander, emptied the coffee out and placed the coffee pot in the locker.

* * *

The 5092 made the branch line run in fairly good shape. Some of the boxes ran warm but that was to be expected of an engine right off the drop-pit. There was a 300 for the Sanford run next day and the third day the motor car was in from the back shop and ready for the run. The snow had about all cleared away and there wasn't so much trouble getting over the road.

Evans breathed a sigh of relief. Things were looking pretty good with the motor car back on the job. Not that he liked motor cars, far from it, but it gave him one more engine.

The motor car started out on time, gleaming spick and span with a new coat of paint. Evans stood out by the roundhouse office and watched it go by. When the staccato exhausts had died away in the distance the foreman bit off a hunk of "horseshoe" and went back in the office.

After looking over the mail, Evans went to see how things were getting along in the roundhouse. Everything was lovely. He went to the storeroom and visited awhile with the storekeeper and returned to the office.

"Now this is more like it," Evans remarked to Harris. "Everything jam up and ready to go with an extra engine O. K. for emergency—that's what I call railroading."

B-r-r-r! The telephone rattled noisily. "Hello. . . . Yes, clerk talking. . . . What? . . . All right, I'll tell him." Harris hung up the receiver. "Going to need that extra engine right now to send out for the motor car," Harris said.

"What happened?" Jim asked.

"Burnt out a bearing or something—that's what the dispatcher said."

Evans swore and went in search of the hostler.

A main crank shaft bearing was burned out on the motor car. Harry Clark, the motor car maintainer, was at loss to explain why. He replaced the damaged bearing and examined all the others. They looked good, so he O. K.'d the car.

Next trip two main bearings burned out. Evans wired for a traveling motor car maintainer. The car was tied up until the maintainer got there.

The traveling maintainer, a man named Davis, came in next evening. He and Clark worked on the motor car engine all night. Bearings were examined, oil lines blown out, oil pressure checked, and seemingly everything that might cause a bearing to burn was carefully examined. Davis rode the car next day. It hadn't made over fifty miles when out went a main bearing. He replaced the bearing while the motor car struggled along on one engine.

The car made the round trip after a fashion. They lost two hours going and almost three on the return trip. Main bearings burned out each time. When Davis got back to Plainville, he was dead on his feet. He told Clark to go home for the night and come back next morning.

A steam locomotive pulled the train next day. The 5075 broke a side rod the same day and that left Evans where he started when the motor car came back; turning engines as fast as they came in, holding them only long enough for a water change, fill the rod cups and pack the cellars.

Davis with Clark and his helper tore the motor car engines completely down. They pulled every piston in both engines and went over every part of the engines like Charlie Chan looking for clues to a murder. Davis was about ready to give up and call it a day when five o'clock came without having found anything that might be causing the trouble. He was holding a piston ring in his hand eyeing it in an abstracted manner. Suddenly he reached in his overall pocket for a scale. He measured the thickness of the ring; it was a sixteenth of an inch thicker than ones regularly used.

"Here's your trouble!" Davis told Clark. "Too much snap to the rings. That makes more pressure on the cylinder walls," he explained.

"Looks like it would burn out connecting rod bearings."

"Yes, it does," Davis admitted. "Anyway, we'll put in new rings the same thickness as ones that were in it before the car went to the back shop."

They worked all night putting in the rings and getting the motor car in shape. Next day the motor car went out on the run and failed, two main bearings burned out. On top of that, the crankshaft was found to be cut so badly that it would have to be renewed.

The master mechanic was frantic. After damning the man that invented internal combustion engines and the person that conceived the idea of using them on a railroad, he wired the factory to send a man to locate the trouble.

* * *

The man from the motor car factory and a howling snow-storm arrived in Plainville at about the same time, about three o'clock in the afternoon. The master mechanic came to the roundhouse with the expert from the factory. After introducing him to Davis, Carter went to the roundhouse office.

Although it wasn't four o'clock it was beginning to get dark. Blinding sheets of snow hurled by the wind plastered the north end walls of the office building. Double headers were called for both westbound passenger trains. The hostler and his helper were running around in circles trying to get engines in and out and keep the ones outside from freezing up.

Evans, muffled in sheepskin coat and fur cap, seemed

to be everywhere at once. Carter, anxious to help, borrowed a suit of overalls and a pair of gloves and pitched in. Five minutes in the blizzard and his ears began to turn blue. He went back in the office hoping to find a fur cap that would cover his ears. Everyone that had fur caps were using them. The clerk suggested using a flag. A red flag, it was a woolen one, was found. Carter folded it diagonally and tied it under his chin, then pulled his soft felt hat down on his head. He presented a comical appearance as he plunged out in the snow.

Carter went to the roundhouse and located Evans. He found the foreman helping the hostler. He had just run an engine in the house and was trying to close the doors when the master mechanic came up. Carter added his weight and the ponderous door swung reluctantly shut.

"Have you got the engines ready for the passenger trains?" Carter asked the foreman.

"Oh, yeah," Evans replied, "they're both ready and outside, one on the lead and the hostler is getting oil and water on the other. I told him to stay with the engines outside and see that none of them freeze up."

"Well, you're not in such bad shape," the master mechanic replied. "What else do you have to get out?"

"Well, there's not anything else except the 5074 for 71. It's doped in here about eight o'clock. Lots of time, but I thought I'd get it outside before the turntable pit gets full of snow. The way it's piling up we won't be able to turn the table much longer without a gang of men to clean it out, and I don't want to put men out there unless I have to," Evans added.

"Well, you get the engine out. I'll line up the table for you," Carter said. "What stall is it in?"

"In number twelve stall," Evans replied, as he walked away.

Carter had some trouble getting the table to turn. The traction wheels wouldn't grip the slick rails; finally he got it going. The blinding snow made it difficult to see when the rails were in line, but finally, with considerable see-sawing, he made it. The rails were in perfect alignment with those from the roundhouse for stall number *eleven.* After he got the table lined, Carter went over and helped Evans open the doors.

"Table lined?" Jim asked.

"Lined and locked," the master mechanic replied.

The foreman walked around the engine to see that everything was clear and climbed up in the cab. He kicked the cylinder cocks open and opened the throttle four or five notches.

Too late, the master mechanic saw that the table was lined for another track. He yelled at the top of his voice, but in the howl of the wind and the hiss of steam from the cylinder cocks of the engine, Evans couldn't hear him.

The first hint Evans had of anything wrong was a tearing, crashing sound as the back end of the tank tore into the turntable cab. Fortunately the engine was moving slowly. As it was, Evans barely managed to stop in time to keep the left rear tank wheels out of the turntable pit.

It wasn't much of a job to get the 5074 back on the track, but the turntable was a different story. The cab was pushed over until it seemed poised ready to dive in the pit. The drum controller was broken loose from its base and looked as though it would never see service again.

"Now ain't that a hell of a mess!" Carter commented when the 5074 was rerailed and run back in the house.

"Well, I guess we'd better call the bridge gang to fix up the turntable cab. I'll tell the electrician to see what can be done about the electrical equipment," Evans replied.

"The bridge gang's out of town; better tell the roundhouse carpenter and two or three machinists to work over and see if we can get the damned thing fixed up. You go on home, I'll stay until it's done," the master mechanic added.

"No, I'll stick around," Evans replied. "I'll get the gang started and take a look at the motor car. I'm anxious to see what's been causing the trouble with it."

Evans located the electrician, the roundhouse carpenter, and the three machinists and broke the news to them that they were to work overtime on the turntable. Johnson happened to be one of the machinists designated to work. That done, Evans went down to where the men were working on the motor car. He met the factory man coming out, a main bearing in hand.

"Well, what did you find?" the foreman asked.

"The trouble is the bearings—they're not the right kind."

"What's wrong with them?" Evans asked.

"Somebody bought bearings not suited for this engine," the factory man explained, "or rather not suited to the crank-shaft in it. These are a cadmium content bearing and they're too hard for the crank-shaft or rather the crank-shaft is not hard enough for them. They'd be O. K. with the proper crank-shaft. We'll have her ready to go in a couple of days."

"That'll be soon enough if this blizzard keeps up," the foreman replied and went to see how the men were getting started on the turntable.

* * *

It was a cold, mean job. A bonfire in the pit and another on the ground outside helped very little. Ned Sparks, the electrician, had rigged up a couple of flood lights so the men could see to work.

It was too cold for the men to walk home to supper. Evans had his car at the roundhouse and he went to town for sandwiches and coffee for the gang about six o'clock. That held them up for a while, but it takes more than a sandwich and a cup of weak restaurant coffee to supply energy and warmth on a job like that.

"Wish I had some coffee," Johnson said about ten o'clock.

Evans overheard him. "I'll go get some more in a little while," he offered.

"Aw, I don't mean that blamed restaurant belly wash —I mean coffee," the machinist replied.

"Well, why don't you go make a pot? I could use some myself." Evans hadn't heard about what happened a few nights before when the master mechanic found the men drinking coffee.

Johnson didn't wait. He beat it to the roundhouse and located the coffee pot. He filled the pot with water and turned steam from a blower line connection in it to heat the water. When the water was boiling hot, he dumped in a pound of coffee, the last on the place. After the coffee was in the pot, the machinist went in search of cups, leaving the pot on the salamander to boil.

"Hot coffee!" he announced to the gang around the turntable cab. The first cup poured he offered to the master mechanic.

Carter looked at it a moment, then took the proffered cup. A twinkle showed in his eyes as he sipped the concoction, thick and black as boiler compound mixed ready for the water tank.

"May not be very good, I lost my coffee tester," Johnson said.

"Don't need it," the master mechanic replied. "If it was any stronger I'd have to chew it and if it was any weaker, I wouldn't want it."

Work picked up after the coffee. More water was added and the pot set on the coals of one of the bonfires. At two a. m. the turntable was running.

Next day ten pounds of coffee was delivered to the roundhouse. The address was to the "Roundhouse Coffee Pot." Nobody asked who sent it—they all knew.

Improved Guide-Bar Grinders

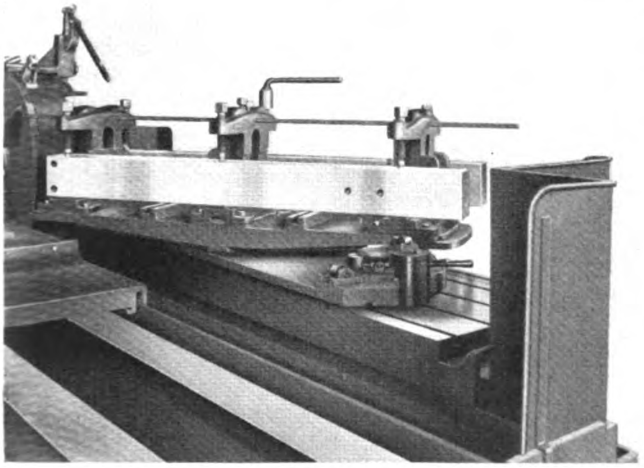
The guide-bar grinding machines, built by the Hanchett Manufacturing Company, Big Rapids, Mich., have been improved in a number of important particulars. One of the things which has been done is to increase the dimensions considerably at several points where experience has shown this to be necessary or desirable. For example, the 30-in. diameter segmental grinding wheel is now carried on a 4-in. spindle mounted in preloaded precision ball bearings. Most of the railroad shops which have older type machines use 30-in. diameter wheels, but the new Hanchett guide-bar grinder is frequently fitted with 36-in. diameter wheels.

Various sizes of motors are used for driving the grinding-wheel spindle; but for guide-bar grinding, where heaviest cuts are being taken, a 35-hp. motor is now recommended. The motor is arranged to drive the wheel spindle by means of sheaves and V-belts. Sprockets and chain can be furnished if desired, but the V-belt type of drive appears to be more popular.

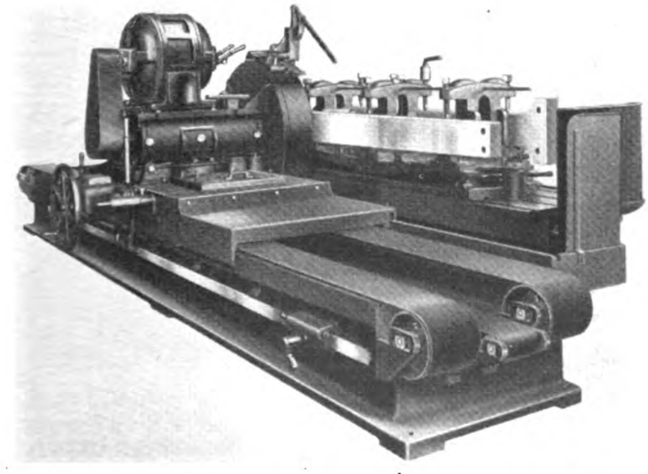
Another improvement of considerable importance is the belt covering which is provided for the carriage ways and rack. This greatly assists in keeping them in condition for a clean and well-lubricated contact with the machine bed ways and the bull gear of the traveling carriage.

The special guide-bar fixture, which is adjustable for different sizes of bars, is pivoted at the center and can be indexed 180 deg. and locked. After one guide-bar has been positioned for grinding, a second bar can be set up on the opposite side of the fixture while grinding is actually taking place on the first guide-bar. In this way, practically no time is lost for loading, and it is possible to secure virtually twice as much production in guide-bar grinding as would ordinarily be obtained on machines without the indexing feature.

While this grinder is made in lengths up to 220 in., the 84-in. machine is usually adequate for most railway shops. This new Hanchett No. 500, 84-in., traveling-wheel grinder, complete with guide-bar fixture, weighs 20,000 lb.



The indexing work table partially revolved

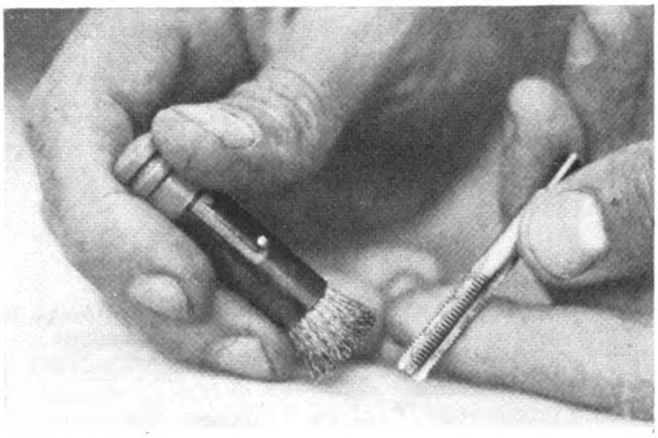


New Hanchett No. 500 84-in. guide bar grinding machine

Cleaning Small Taps And Tapped Holes

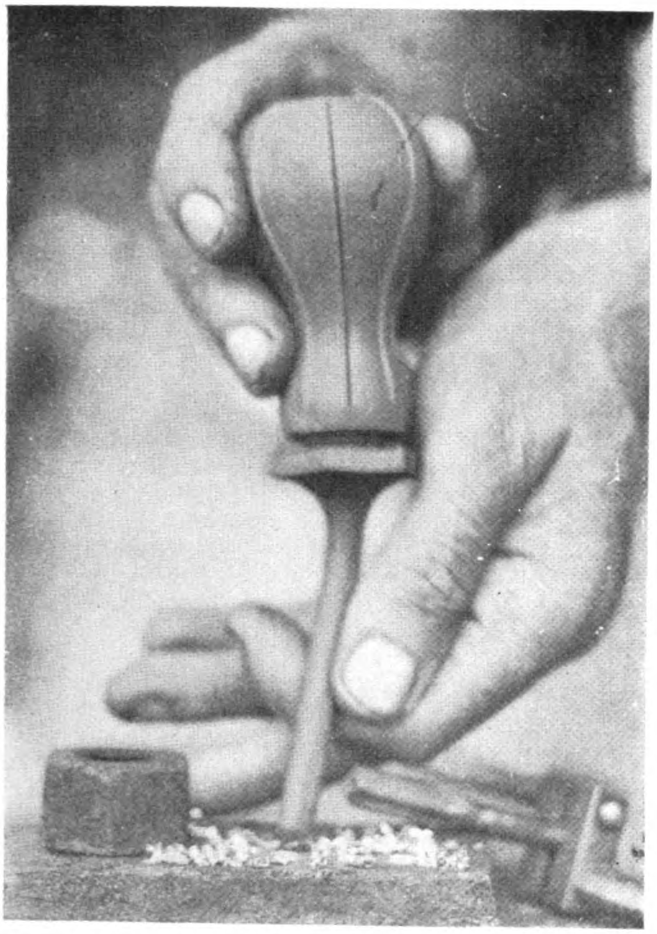
By Frank Bentley

The threads in small hand taps are in many instances hard to clean out quickly and thoroughly, either before or after making use of the tool. The finer the thread in many metals, the more important it is that the small tap be absolutely free of cuttings from another job in other metal. Around the shop where an air blast is always handy, it is easily done, but out on the road it is not so easy. Small taps are difficult to wipe clean with anything, and a handy cleaning device which can be kept in the small tool kit or carried in the pocket is simply an ordinary inexpensive suede brush. The bristles of this brush are just stiff enough and soft enough to serve for this purpose nicely. When not in use the brush is simply drawn up in the tube which is a part of the handle, and locked, protecting the light but stiff bristles and keeping them from contact with things in the pocket or tool bag.



Simple suede brush effectively used in cleaning a small tap

When tapping out small holes, which often bottom some depth from the end of the tap, it is of course necessary to keep the hole quite free and clean of chips and cuttings. Small taps are frequently and easily broken if this is not carefully attended to. When an air jet or



Rubber hydrometer bulb and tip used in blowing out small tapped holes

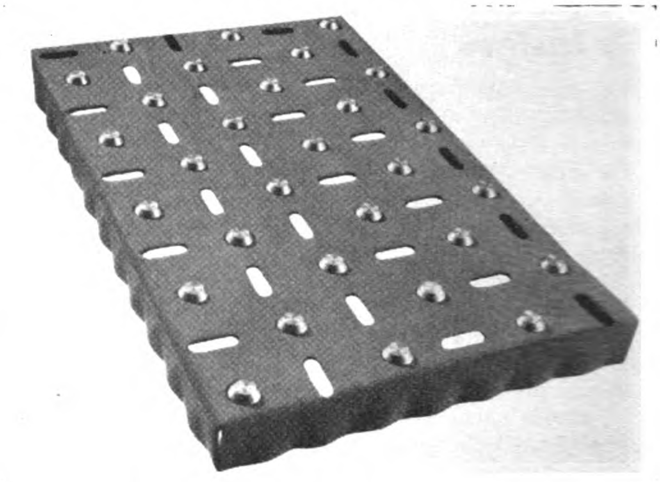
blast is not available a very handy device for this operation consists of a small hydrometer bulb and tip, used as shown. Compressing the bulb firmly and quickly sends a sharp strong air jet through the small end tip, which readily blows out dirt or chips in any small hole in the process of being tapped out. Made entirely of soft rubber, this little affair is indestructible and can be kept with any of the tools in the kit.

Bethlehem Steel Paving Plates

A new type of permanent and protective surfacing for concrete floors and paving, designed for installation on the surface of concrete slabs to which they are anchored and with which they become an integral part, has been placed on the market by the Bethlehem Steel Company, Bethlehem, Pa.

These Bethlehem steel paving plates are of 1/8-in. rolled steel and are available in two types. One is intended for use on roadways; the other for plant floors and loading platforms. Both types are identical, except that the one for roadways is equipped with button-head studs, making it a non-skid plate. As shown in the illustration, the sides are perpendicular to the surface and are so crimped as to give the plates a firm anchorage in the concrete. Additional anchorage is provided by studs which extend into the concrete, and, when these plates are laid the fresh concrete fills the slots to the top of the plate, providing additional bond between concrete and plate and increasing its non-skid surface. The road-type plate is applicable to thoroughfares, tunnels and bridges, that carry heavy continuous traffic.

The floor-type paving plate has a smooth surface. The long-shank anchorage studs with flat heads, fastening through countersunk holes, makes them flush with the top surface of the plate. Such smooth surface plates find application in shops, warehouses, docks, and loading platforms where heavy goods are ordinarily conveyed on

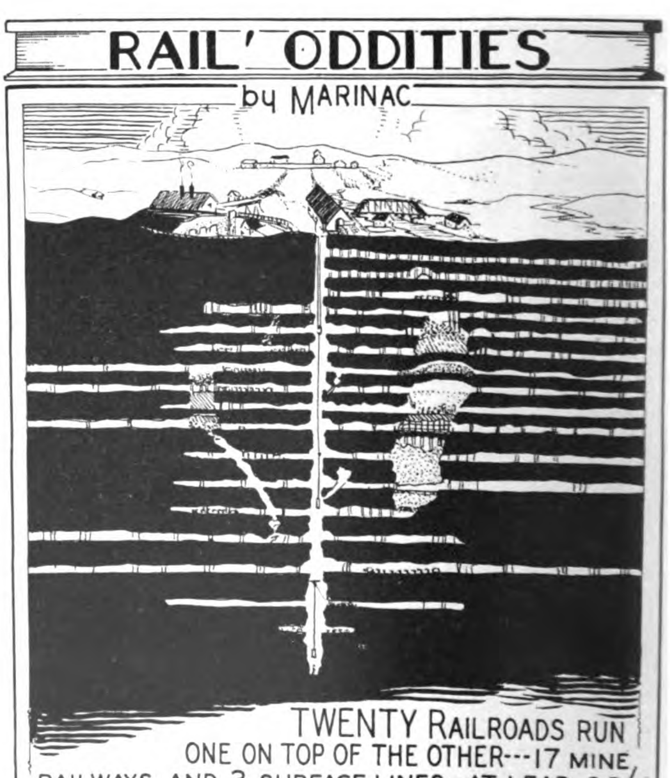


Road-type Bethlehem steel paving plate

trucks with steel wheels of small diameter and width which are hard on floor surfaces. Like the road plates, the floor type plates are anchored securely to the concrete slab and become, in effect, an integral part of it.

The standard size of Bethlehem paving plates is 12-in. by 18-in., with 1½-in. sides.

* * *



For explanation see page 134

Among the Clubs and Associations

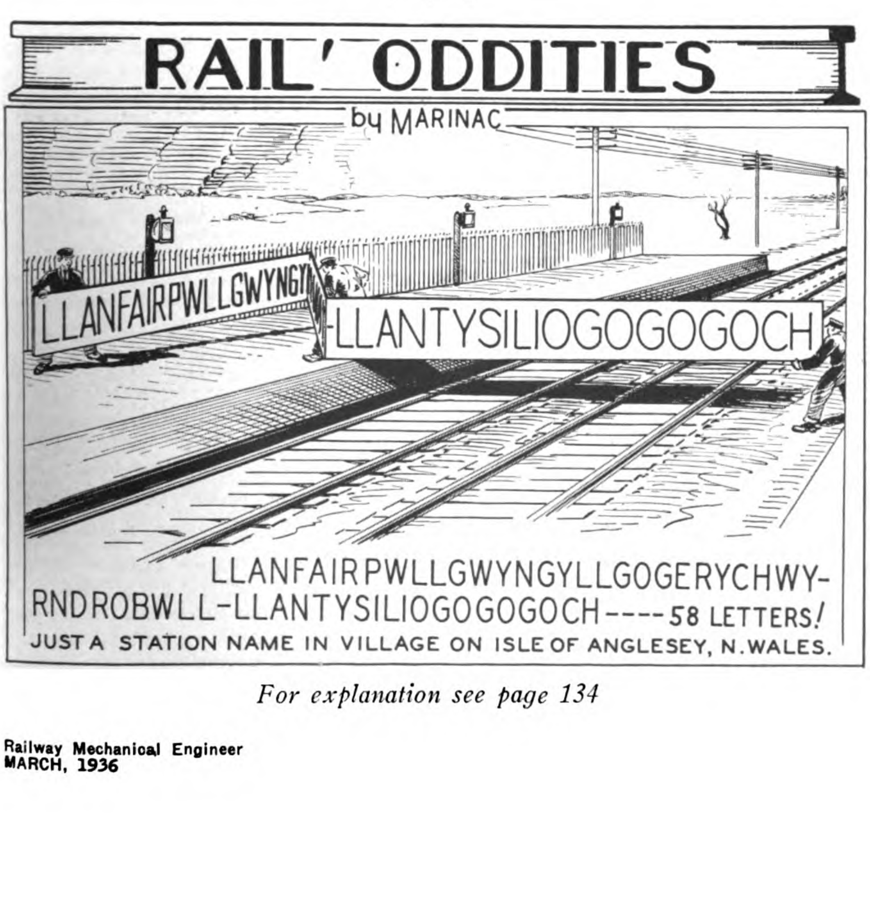
Canadian Railway Club.—Motion pictures and slides will be used to illustrate a discussion of air conditioning of equipment by S. M. Anderson of the Sturtevant Company, Boston, Mass., at 8 p.m. on March 9 at the Windsor Hotel, Montreal.

Southern and Southwestern Railway Club.—At 10 a.m. on March 19 at the Ansley Hotel, Atlanta, Ga., Jas. Grant, superintendent motive power, Atlantic Coast Line, and E. C. Hasse, general manager, Oxweld Railroad Service Company, will discuss the operation of flame cutting machines.

Northwest Car Men's Association.—J. J. McDermott, representative of the Bureau of Explosives at St. Paul, Minn., will discuss the inspection and interchange of cars of explosives and other dangerous articles at the meeting to be held at 8 p.m. on March 2 at the Midway Club Rooms, St. Paul.

New England Railroad Club.—At the fifty-third annual meeting, to be held on March 10 at the Copley-Plaza Hotel, Boston, Mass., a talking still picture machine will be used to show different types of valves, their construction and use in the railroad field. New officers will be elected. The meeting starts with dinner at 6:30 p.m.

* * *



For explanation see page 134

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings and places of meetings of mechanical associations and railroad clubs:

Air-Brake Association.—T. L. Burton, c/o Westinghouse Air Brake Company, 3400 Empire State Building, New York.

Allied Railway Supply Association.—F. W. Venton, Crane Company, Chicago.

American Railway Tool Foremen's Association.—G. G. Macina, 11402 Calumet avenue, Chicago.

American Society of Mechanical Engineers.—C. E. Davies, 29 West Thirty-ninth street, New York.

Railroad Division.—Marion B. Richardson, 192 East Cedar street, Livingston, N. J.

Machine Shop Practice Division.—G. F. Nordenholt, 330 West Forty-second street, New York.

Materials Handling Division.—F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

Oil and Gas Power Division.—M. J. Reed, 2 West Forty-fifth street, New York.

Fuels Division.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

Association of American Railroads.—J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

Division I.—Operating.—Safety Section.—J. C. Caviston, 30 Vesey street, New York.

Division V.—Mechanical.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

Committee on Research.—E. B. Hall, chairman, care of Chicago & North Western, Chicago.

Division VI.—Purchases and Stores.—W. J. Farrell, 30 Vesey street, New York.

Division VIII.—Motor Transport.—Car Service Division.—C. A. Buch, Transportation Building, Washington, D. C.

Association of Railway Electrical Engineers.—Jos. A. Andreucetti, C. & N. W., 1519 Daily News Building, 400 West Madison street, Chicago, Ill.

Canadian Railway Club.—C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

Car Department Officers Association.—A. S. Sternberg, master car builder, Belt Railway of Chicago, 7926 South Morgan st., Chicago.

Car Foremen's Association of Chicago.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago, Ill.

Car Foremen's Association of Omaha, Council Bluffs and South Omaha Interchange.—J. R. Leach, car department, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p.m. at Union Pacific shops, Council Bluffs.

Central Railway Club of Buffalo.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

Eastern Car Foremen's Association.—E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

Indianapolis Car Inspection Association.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

International Railway Fuel Association.—T. D. Smith, 1660 Old Colony Building, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 West Wabasha street, Winona, Minn.

International Railway Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

Master Boilermakers' Association.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, excepting June, July, August and September, at Copley-Plaza Hotel, Boston.

New York Railroad Club.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

Northwest Car Men's Association.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium Building, St. Paul.

Pacific Railway Club.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately—June, in Los Angeles and October, in Sacramento.

Railway Club of Greenville.—J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

Railway Club of Pittsburgh.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

Railway Fire Protection Association.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md.

Railway Supply Manufacturers' Association.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

Southern and Southwestern Railway Club.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

Toronto Railway Club.—R. H. Burgess, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August.

Traveling Engineers' Association.—A. T. Pfeiffer (president), New York Central, Syracuse, N. Y.

Western Railway Club.—C. L. Emerson, executive secretary, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

NEWS

Safety at Portsmouth Shops

THE Norfolk & Western reports that the men in its shops at Portsmouth, Ohio, worked from August 23, 1934, to January 24, 1936, or 519 consecutive days, without a reportable accident. During this time the number of man-hours recorded was 3,519,789. Working with this degree of carefulness, a shop employing 100 men might be expected to go with a clean record for 14 years.

Royal Blue Model Contest

THE Baltimore & Ohio in conjunction with The Model Craftsman, a publication devoted to model building, has just launched a national contest for the best working model of the Royal Blue—the Baltimore & Ohio's new train between New York and Washington, D. C. Only amateur model builders and groups of amateurs, including railroad model clubs, are eligible to compete in the contest in which prizes totaling $1,150 will be awarded to winners—a first prize of $500; second prize, $300; third prize, $100; fourth prize, $50; and $25 each for the eight next best models.

The competition will close at midnight, November 15, 1936, and prizes will be awarded by five judges to be selected later.

P. & S. Division Invites Papers

A COMPETITION for papers on railway supply work has been announced by Division VI, Purchases and Stores, A. A. R. This contest will be similar to competitions held in previous years and is open to all purchases and stores department employees below the rank of assistant purchasing agent or assistant general storekeeper. The author of the two best papers will be invited to the next annual meeting of the division and will receive special mention in the annual proceedings. E. J. Lamneck, purchasing agent, Pennsylvania; C. H. Murrin, general storekeeper, Louisville & Nashville, and E. Harty, assistant general storekeeper, Southern Pacific, have been selected to judge the papers entered in the competition. Applicants may choose any subject related to the purchasing or the storing and distributing of material, and must submit their papers to the secretary of the division not later than April 15.

P.W.A. Railroad Loans Transferred to R.F.C.

DECLARING that the railroad construction and improvement program financed by $198,000,000 of loans from the Federal Emergency Administration of Public Works "is one of the brightest chapters of P.W.A.," Administrator Harold L. Ickes on February 13 announced the abolition of its Division of Transportation Loans, organized in the Fall of 1933, and the transfer of its remaining activities to the Reconstruction Finance Corporation, which also has broad powers to make loans to railroads and which has purchased all of the railroad securities taken by the P.W.A. The R.F.C. has already resold $73,602,000 of the securities to private investors at a profit to the government of some $4,000,000.

C. B. & Q. Equipment Program

THE Chicago, Milwaukee, St. Paul & Pacific will undertake a $5,000,000 equipment program, the Reconstruction Finance Corporation having agreed to purchase equipment trust certificates for 80 per cent of the value of the new equipment. An order has been placed with the American Locomotive Company for a streamlined steam locomotive of the same type now used on the Hiawatha, which will be used for relief service on the Hiawatha or for the operation of extra sections of the train. A total of 1,500 freight cars, including 1,000 automobile cars and five hundred 50-ton gondola cars, will be constructed in company shops. Passenger train cars to be built include 20 day coaches, 2 dining cars, 2 taproom cars and 3 parlor cars, all air-conditioned and partially streamlined, 5 baggage and 5 mail-express cars. All will be of steel-welded construction, about one-third lighter in weight than the conventional type car.

Improvement Programs

THE Denver & Rio Grande Western plans to spend $6,000,000 during 1936 for the repair and rebuilding of locomotives, improvement of roadbed, air conditioning of passenger cars and the laying of rail in at least 60 miles of track. The program will be financed entirely by the earnings of the road.

The Illinois Central, which has borrowed $3,000,000 from the P.W.A. for repairs to equipment, has started its program. During 10 months, from January 1, 141 locomotives and 4,637 freight cars, including box, automobile and coal cars, will be repaired, while during the period from February to June 56 passenger cars, including baggage, coaches, parlor cars and dining cars, will be repaired. At the same time, 52 of these cars will be air-conditioned.

The Lehigh Valley on January 30 received a P.W.A. allotment of $1,755,000 which will be used to build 1,000 coal cars in the company's shops in Sayre and Pack-

New Equipment

LOCOMOTIVE ORDERS

Road	No. of locos.	Type of locomotive	Builder
B. & L. E.	4	0-8-0	American Locomotive Co.
	10	2-10-4	Baldwin Locomotive Works
C. M. St. P. & P....	1	4-4-2 streamline	American Locomotive Co.
L. & N. C.	1	0-6-0	Baldwin Locomotive Works
Interoceanic of Mexico	5 [1]	2-8-0	American Locomotive Co.
Union R. R. Co.....	5	0-10-2	Baldwin Locomotive Works
	5	0-6-0	Lima Locomotive Works
Union Pacific	15 [2]	4-6-6-4	American Locomotive Co.
Inland Steel Co......	3	0-6-0	....

LOCOMOTIVE INQUIRIES

Road	No. of locos.	Type of locomotive	Builder
N. Y. N. H. & H...	10 [3]	Steam	....
Northern Pacific	12 [4]	4-6-6-4	....

CAR ORDERS

Road	No. of cars	Type of car	Builder
A. T. & S. F........	50	70-ton triple hopper	American Car & Foundry Co.
	500	50-ton box	Pullman-Standard
B. & L. E.	1,000	90-ton hopper	Pullman-Standard
	750	70-ton hopper	American Car & Foundry Co.
	250	70-ton hopper	General American Car
C. M. St. P. & P....	250 [5]	Refrigerator	General American Trans. Corp.
Missouri Pacific	300 [6]	40-ton box	American Car & Foundry Co.
Phillips Petroleum Co.	10	Tank	General American Tank Car Co.
Shell Chemical Co. of California	15	8,000-gal tank	General American Tank Car Co.
Union R. R. Co......	600	70-ton gondolas	Pressed Steel Car Co.
	200	70-ton gondolas	Greenville Steel Car Co.
	100	70-ton gondolas	Ralston Steel Car Co.
	100	70-ton gondolas	Magor Car Corp.
Western Pacific	100	50-ton Hart selective ballast	American Car & Foundry Co.

CAR INQUIRIES

Road	No. of cars	Type of car	Builder
Great Northern	500	75-ton ore	....
Northern Pacific	500 [7]	50-ton gondola	....
	250	50-ton flat	....
N. Y. N. H. & H....	50 [3]	Passenger	....

[1] These locomotives will have a total weight in working order of 119,000 lb., 18 by 22 in. cylinders and will be of 36-in. gage.

[2] These locomotives will be of the four-cylinder simple articulated type for fast freight service on mountain grades. They will have 22-in. by 32-in. cylinders, a total weight of engine in working order of 545,000 lb., a tractive effort of 100,000 lb. and twelve 69-in. driving wheels. The tenders will have a capacity of 19,000 gal. of water and 22 tons of coal.

[3] Subject to the approval of the court. The cars are to be similar to the 50 bought in 1934. Each will seat 92.

[4] These locomotives are to be equipped with roller bearings and will have a tractive force of 106,000 lb., a length of 127 ft. 1¼ in., a height of 16 ft. 4 in., a total weight in working order of 1,025,000 lb., and a tender capacity of 27 tons of coal and 22,000 gal. of water.

[5] These steel-sheathed refrigerator cars are being built for the Union Refrigerator Transit Company which will lease them to the C. M. St. P. & P.

[6] For use on the International Great Northern.

[7] This company will build 250 stock cars of 40 tons' capacity in its own shops.

erton, Pa. Previous loans to the Lehigh Valley total $5,345,000 for rebuilding old equipment and purchasing new cars and locomotives.

The Wabash has been authorized by the district court to spend $476,694 for repairing 1,310 freight cars and dismantling 394 freight cars and 16 locomotives.

The Northern Pacific will spend $4,000,000 for 12 locomotives and 1,000 freight cars and $338,000 for improvements to track, bridges and terminals to permit the operation of these locomotives in the Montana mountain territory between Livingston, Helena and Missoula.

The New York, New Haven & Hartford program for 1936 includes applying cast steel side frames in place of arch bar side frames on some 2,500 freight cars and making such other repairs as required, including painting.

The Chicago, Milwaukee, St. Paul & Pacific will undertake a $5,000,000 equipment program, the Reconstruction Finance Corporation having agreed to purchase equipment trust certificates for 80 per cent of the value of the new equipment. An order has been placed with the American Locomotive Company for a streamline steam locomotive of the same type now used on the Hiawatha, which will be used for relief service on the Hiawatha or for the operation of extra sections of the train. A total of 1,500 freight cars, including 1,000 automobile cars and five hundred 50-ton gondola cars, will be constructed in company shops. Passenger train cars to be built include 20 day coaches, 2 dining cars, 2 taproom cars and 3 parlor cars, all air-conditioned and partially streamlined, 5 baggage and 5 mail-express cars. All will be of steel-welded construction, about one-third lighter in weight than the conventional type car.

Air Conditioning

Canadian railways are making arrangements to introduce air conditioning into their train services, according to a joint statement issued by the managements of the Canadian National and the Canadian Pacific. For the coming summer several trains will be so equipped on the more heavily traveled lines of both companies. The fitting of present equipment will be undertaken gradually so that the types of air-conditioning devices used for the contemplated year-round operation will be the latest obtainable. Committees of mechanical and traffic officers of the two Canadian railways have been investigating air-conditioning devices for passenger equipment for some time and the work of equipping cars of both roads is now going forward. For the present year it is likely that this work will be confined to sleeping, parlor and observation cars. It is anticipated, however, that the air conditioning will be gradually extended to all passenger cars of practically all important main line trains.

The Illinois Central has placed an order with the Pullman Standard Car Manufacturing Company for Pullman shaft-driven, mechanical air-conditioning systems for 52 passenger cars.

The Waukesha Motor Company, Waukesha, Wis., has received orders for air-conditioning equipment as follows:

Chicago & North Western	28 ice engines
Illinois Central	1 ice engine
Missouri Pacific	1 ice engine
Texas & Pacific	1 ice engine

The New York, Chicago & St. Louis has placed an order with the Pullman-Standard Car Manufacturing Company for Pullman shaft-driven, mechanical air-conditioning systems for two coaches.

The New York Central is air conditioning 53 railroad-owned coaches and dining cars, and, in addition, the Pullman Company will air condition 22 cars for service on the New York Central, making a total of 632 air-conditioned cars on this road.

The Reading and Central of New Jersey have authorized a program of installing air-conditioning equipment in 21 passenger coaches as follows: On the Reading, 11 coaches, 3 combination cars and 2 cafe cars; on the Central of New Jersey, 3 coaches and 2 combination cars.

The New York, New Haven & Hartford has been granted permission by the United States District Court for Connecticut to air condition 46 of its passenger cars with ice units, which have been purchased from the B. F. Sturtevant Company, and 15 electro-mechanical and 1 ice unit purchased from the Safety Car Heating & Lighting Company. An additional 26 cars on this road belonging to the Pullman Company will also be air conditioned.

Supply Trade Notes

Henry S. Griffin, formerly general superintendent of the Morris Car Lines, has become associated with the Ajax Hand Brake Company, Chicago.

R. D. Bartlett, general manager of the Franklin Steel Works, Franklin, Pa., has been appointed assistant to the president of the Chicago Railway Equipment Company, with headquarters at Chicago.

The Markham Supply Company, Chicago, has been appointed general railway representative for the Chicago, Omaha, Neb., and Twin Cities territory for the Auto-Tite Joints Company, Pittsburgh, Pa.

James E. DeLong, executive vice-president of Waukesha Motor Company, Waukesha, Wis., has been appointed general manager. Mr. DeLong, who joined the organization in 1923, will also continue as head of the executive board.

Lester W. Seago, for the past ten years with the Ready-Power Company, Detroit, Mich., has been appointed eastern district manager, with office at 1775 Broadway, New York, and Wesley Davey, who has been with the company for over five years, will have charge of all Ready-Power service in the eastern territory.

J. M. Lammedee, formerly sales engineer of the Worthington Pump & Machinery Corporation, with headquarters at Chicago, has been appointed mechanical engineer of the Wilson Engineering Corporation, to succeed V. E. McCoy, who has resigned to become mechanical engineer of the Sullivan Valve & Engineering Corporation, Butte, Mont.

William Page, formerly sales engineer of the Acme Steel Company, has been placed in charge of the railway reclamation division of Erman-Howell & Co., Chicago, and C. A. Reagan, formerly associated with Briggs & Turivas, has joined the sales organization of Erman-Howell.

J. B. Strong has resigned as president of the Ramapo Ajax Corporation, a subsidiary of The American Brake Shoe & Foundry Company, at the age of 60 years. In the future he will act as a consulting engineer, particularly for The American Brake Shoe & Foundry Company and its affiliates in co-operation with its research department, with address 230 Park avenue, New York.

R. H. Sonneborn, formerly associated with the Youngstown Sheet & Tube Company, with headquarters at Detroit, Mich., has been appointed special sales representative of the tubular division of the Republic Steel Corporation, with headquarters at Cleveland, Ohio. Charles W. East, assistant manager of sales in the pipe division, with headquarters at Birmingham, Ala., has been appointed district sales manager, with headquarters at Houston, Tex., to succeed Robert E. Lanier, resigned.

The Peerless Equipment Company has elected the following officers: Chairman of the board, F. A. Poor; president, A. A. Helwig; first vice-president and treasurer, Philip W. Moore, with headquarters at 310 South Michigan avenue, Chicago, and vice-president, Floyd K. Mays, with headquarters at 230 Park avenue, New York. The Peerless Equipment Company continues the sale of the Peerless draft gears; the USL Battery Corporation's batteries for air-conditioning, car lighting, signaling and other purposes; the Journal Box Servicing Corporation's process and equipment for waste renovation and oil reclamation; and the Burgess Battery Company's dry cells.

A. A. Helwig, who has been elected president, was born at Minneapolis, Minn., in 1892, and served his apprenticeship in the mechanical department of the Minneapolis & St. Louis. Later he was employed in train service on this railroad, the Great Northern and the Chicago, Milwaukee, St. Paul & Pacific. In 1915 he was appointed general foreman of the Alton at Kansas City, Mo., and the following year became traveling inspector in the mechanical department. In 1917 he entered the Army as a second lieutenant and in 1920 resigned as a major after serving three years in France with the First Army Engineers.

He returned to railroad service in that year as superintendent of the car department of the Kansas City Terminal Company at Kansas City, and in 1925 resigned to become southwestern sales manager of the Bradford Corporation. In 1930 was

(c) Moffett Studio

A. A. Helwig

elected vice-president at Chicago and in March, 1932, resigned to form the Peerless Equipment Company.

George Dandrow, assistant manager of the New York district of the Johns-Manville Sales Corporation, has been appointed manager of that district with office at New York. Mr. Dandrow joined the Johns-Manville organization in 1922. After five years in its Boston branch, Mr. Dandrow joined the general engineering staff at New York and for the last few years has been assistant manager, New York district.

Frederick H. Thompson, vice-president and director of the Simmons-Boardman Publishing Company, publisher of *Railway Mechanical Engineer,* has been elected also to the board of directors of its parent company—the Simmons-Boardman Publishing Corporation—and Frederick C. Koch, also a vice-president of the former, has been elected to its directorate.

Mr. Thompson, who was born in Cleveland, Ohio, started his business career in 1902 as a newspaper reporter in New York and served for a time as a dramatic critic. From 1904 to 1907 he was eastern representative of the Music Trade Review, becoming in the latter year business manager of the American Engineer and Railroad Journal, a position which he held until 1912, when that publication was merged into the *Railway Mechanical Engineer*. Shortly after the merger Mr. Thompson joined the Simmons-Boardman organization as business manager of the *Railway Mechanical Engineer,* serving in that connection from 1912 until 1920, when he was appointed general manager for the

Frederick H. Thompson

Simmons-Boardman Publishing Company in the Central district, with headquarters at Cleveland, Ohio. In 1924 Mr. Thompson was elected a vice-president. He was elected to the Simmons-Boardman Publishing Company directorate in 1931.

Frederick C. Koch was born in Jersey City, N. J., on June 9, 1893, and was educated in the public schools of New York. He entered the employ of the Railway Age-Gazette in 1909 in a minor capacity and rose through various clerical positions to the managership of the advertising make-up department. In 1917 he became advertising sales representative for all Simmons-Boardman transportation publications with the title of assistant to vice-president. In 1925 he was appointed business manager of Railway Engineering and Maintenance, which position he still holds

Frederick C. Koch

along with the vice-presidency of the Simmons-Boardman Publishing Company to which he was elected in 1931.

Henry A. Wahlert, who retired in 1932 as representative at St. Louis, Mo., of the Westinghouse Air Brake Company, died in St. Louis on January 7.

Obituary

Harry Daniels, manager of the railroad department of the West Disinfecting Company, who died on January 19 at Evanston, Ill., of bronchial pneumonia, was born in Boston, Mass., in 1873, and started his railroad career at the age of 14 with the Concord & Montreal, now a part of the Boston & Maine. Later, he entered the employ of the New York, New Haven & Hartford, occupying various positions until 1908 when he left the railroad to enter the employ of the West Disinfecting Company as a salesman. In 1918 he was appointed manager of railroad sales for the United States and Canada.

Personal Mention

General

N. M. Eberhart has been appointed fuel analyst of the Florida East Coast, with headquarters at St. Augustine, Fla.

R. K. Carr, chief motive power clerk of the Norfolk & Western at Roanoke, has been appointed assistant to superintendent of motive power.

D. W. Cross has been appointed superintendent of motive power of the Detroit & Toledo Shore Line, with headquarters at Toledo, Ohio, succeeding J. F. Hazel.

Charles Scott Taylor, who has been appointed superintendent of motive power of the Atlantic Coast Line at Rocky Mount, N. C., was born on January 7, 1886, at Wilmington, N. C. He attended grammar school and McGuire's Preparatory School at Richmond, Va., and took International

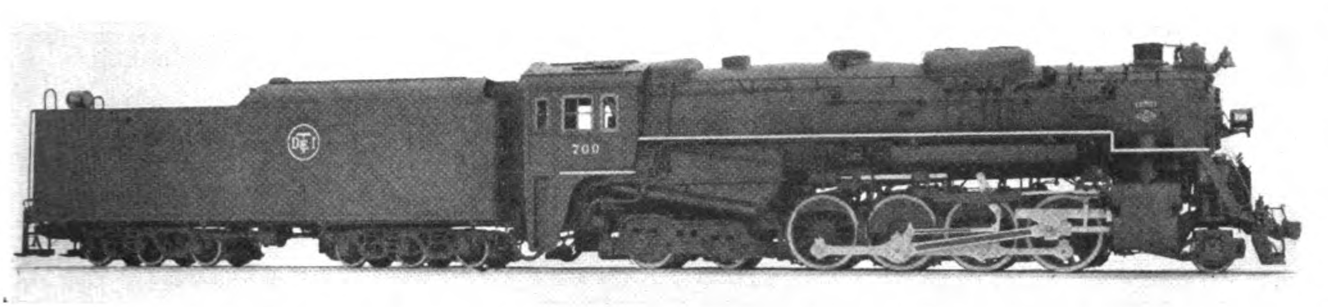
C. S. Taylor

Correspondence School courses in mechanical engineering and on air brakes. He became a machinist apprentice in the employ of the Atlantic Coast Line on August 26, 1902. He completed his apprenticeship on September 4, 1906, and until June 1, 1909, was a machinist. On the latter date Mr. Taylor was promoted to the position of assistant enginehouse foreman at South Rocky Mount; on October 1, 1909, was transferred to South Richmond, Va.; on January 1, 1911, was appointed general enginehouse foreman at Florence, S. C.; on March 18, 1912, became general foreman at Wilmington; on January 1, 1918, was promoted to the position of master mechanic at Wilmington; on November 1, 1923, was appointed shop superintendent at Emerson shops, Rocky Mount; on June 1, 1933, was transferred to the position of master mechanic at Rocky Mount, and on January 16 of this year was appointed superintendent motive power, Northern division.

(Turn to next left-hand page)

NEW HEAVY POWER

FOR



Cylinders, 25 in. x 30 in. ● Boiler Pressure, 250 lb. ● Drivers, 63 in. ● Total Wheelbase, 86 ft., 1¼ in.
Tractive Effort at 85% cut-off, 63,250 lb. ● Weight on Drivers, 248,600 lb.
Weight Total Engine, 411,500 lb. ● Weight Tender Loaded, 361,370 lb.

THE

DETROIT, TOLEDO AND IRONTON

RAILROAD COMPANY

DT&I

Delivery was completed by Lima Locomotive Works, Incorporated, on December 31, 1935 of four 2-8-4 Type Heavy Freight locomotives to the Detroit, Toledo and Ironton Railroad Company.

This power is designed to meet the requirement of heavy freight service.

LIMA LOCOMOTIVE WORKS, INCORPORATED, LIMA, OHIO

LIMA
LOCOMOTIVE WORKS
INCORPORATED

J. B. Blackburn has been appointed engineer of motive power of the Advisory Mechanical Committee of the Van Sweringen Lines, with headquarters at Cleveland, Ohio, succeeding D. S. Ellis.

P. J. Norton, master mechanic on the Union Pacific, with headquarters at Pocatello, Idaho, has been appointed district superintendent, motive power and machinery, of the Central, Northwestern and Southwestern districts, with the same headquarters.

William S. Lammers, who has been appointed mechanical valuation engineer of the Atchison, Topeka & Santa Fe at Topeka, Kan., has been with the Santa Fe in various capacities in the mechanical department for 32 years. Mr. Lammers was born on January 2, 1884, at Ft. Madison, Iowa, and received a public school, business college and correspondence school education, specializing in mechanical drawing and general accounting. He entered the service of the Santa Fe in 1903 as a enginehouse clerk at Ft. Madison, Ia., serving for the next 13 years at various points

William S. Lammers

in this capacity and as a car clerk, equipment inspector, machinist helper, machinist, shop timekeeper, head shop timekeeper, and assistant bonus supervisor. In 1916 he entered the valuation department as valuation assistant, later being promoted to office engineer and then to assistant mechanical valuation engineer.

D. S. Ellis, engineer motive power of the Advisory Mechanical committee of the Van Sweringen Lines, has been appointed mechanical assistant to vice-president of the Chesapeake & Ohio, the New York, Chicago & St. Louis and the Pere Marquette, with headquarters at Cleveland. Mr. Ellis was born on January 25, 1897, at Warwick, N. Y. He entered railway service in 1916 as a clerk in the office of the auditor of the Lehigh & Hudson River. In the following year he became a clerk in the office of the auditor of freight accounts of the New York Central, later serving as a machinist and as acting enginehouse foreman. In 1918 he became a draftsman and later served as a checker, calculator, designer and traveling engineer. In 1924 he was appointed assistant engineer and in 1925 became assistant engineer of motive power. On May 1, 1929, Mr. Ellis was appointed Eastern district manager, and subsequently manager, of the Railroad division of the Worthington Pump & Machinery Corporation. On October 1, 1932, he resigned from the service of the Worthington company to become engineer of motive power of the Advisory Mechanical committee of the Van Sweringen Lines.

D. S. Ellis

Master Mechanics and Road Foremen

S. C. Smith has been appointed master mechanic of the Central district of the Union Pacific, with headquarters at Pocatello, Idaho, to succeed P. J. Norton.

Willard Bourden Middleton, who has been appointed master mechanic of the Atlantic Coast Line at Rocky Mount, N. C., was born on October 16, 1882, at Warsaw, N. C. He attended North Carolina State College for two years (1902-1904) and entered the service of the A.C.L. as a machinist apprentice on June 7, 1904. Having been allowed six months on his

W. B. Middleton

apprenticeship for technical training he became a machinist on February 1, 1908. In February, 1909, he was appointed assistant roundhouse foreman; in the fall of 1911, became assistant to erecting shop foreman, and in May, 1912, was promoted to enginehouse foreman. Mr. Middleton acted as master mechanic for three months in 1918, and was appointed general foreman of the Emerson shops on November 15, 1920. He became master mechanic at Rocky Mount on January 16 of this year.

Car Department

A. H. Muttitt, assistant car foreman of the Canadian National at Port Mann, B. C., has been appointed car foreman, succeeding F. Spick, retired.

Shop and Enginehouse

G. Shipley, locomotive foreman of the Canadian National at The Pas, Man., has been transferred to the position of locomotive foreman at Rivers, Man.

F. E. Demorest, assistant locomotive foreman of the Canadian National at Nutana, Sask., has been appointed locomotive foreman, with headquarters at Prince Albert, Sask.

P. J. Sproule, locomotive foreman of the Canadian National at Rivers, Man., has been transferred to the position of locomotive foreman at Sioux Lookout, Ont.

F. C. Parsons, a machinist of the Canadian National at Rainy River, Ont., has been promoted to the position of night foreman at The Pas, Man.

T. Leevers, locomotive foreman of the Canadian National at Sioux Lookout, Ont., has been transferred to the position of locomotive foreman at Transcona, Man.

J. C. Benson, enginehouse foreman of the Atlantic Coast Line, has been promoted to the position of general foreman, with headquarters at Jacksonville, Fla.

J. Carnochan, leading hand machinist of the Canadian National at the Transcona locomotive shop, has been promoted to the position of millwright foreman at Transcona, Man.

L. E. Hart, general boiler maker foreman of the Atlantic Coast Line, has been appointed general foreman locomotive department, with headquarters at Rocky Mount, N. C.

Peter Young, general foreman of the Corwith (Ill.) reclamation plant of the Atchison, Topeka & Santa Fe, has been appointed general superintendent of reclamation at the same point, to succeed R. K. Graham, deceased.

Purchasing and Stores

Elwyn T. Ricker has been appointed storekeeper of the Maine Central and Portland Terminal Company, with headquarters at Deering Junction, Me.

J. G. Stuart, assistant purchasing agent of the Chicago, Burlington & Quincy, with headquarters at Chicago, has retired because of continued ill health. Mr. Stuart had been 48 years in the service of the Burlington.

W. F. Myers, local storekeeper on the Chicago, Burlington & Quincy at McCook, Nebr., has been appointed general storekeeper of the Fort Worth & Denver City, the Wichita Valley and the Burlington-

(*Turn to next left-hand page*)

Rock Island, with headquarters at Childress, Texas, succeeding George Baker, deceased.

J. C. Hart, chief clerk to the district storekeeper of the Chicago, Milwaukee, St. Paul & Pacific at Minneapolis, Minn., has been appointed division storekeeper of the LaCrosse and River division, with headquarters at La Crosse, Wis.

D. H. Phebus, chief clerk to the general storekeeper of the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., has been promoted to the position of district storekeeper of the Southern district, with headquarters at Savanna, Ill.

J. C. MacDonald has been appointed to the newly-created position of district storekeeper of the Tacoma district of the Chicago, Milwaukee, St. Paul & Pacific, with jurisdiction over the territory between Tacoma and Harlowton, Mont. Mr. MacDonald's appointment was made following the death recently of A. J. Kroha, assistant general storekeeper, Lines West, whose position has been abolished.

R. D. Long, general storekeeper of the Chicago, Burlington & Quincy, has been appointed purchasing agent, with headquarters as before at Chicago, to succeed Percival Hunter, deceased. Mr. Long has been connected with the Burlington for more than 43 years. He was born on February 22, 1877, at Aurora, Ill., and entered the employ of the Burlington on November 1, 1892, as a messenger at the Aurora store. In March, 1901, after having held various positions at that point, he was promoted to foreman, which position he held until October, 1906, when he became chief clerk at the Aurora store. Mr. Long was transferred to the office of the general storekeeper at Chicago on February 1, 1910. Four years later he became assistant general storekeeper at that point and late in 1931 he was appointed general storekeeper.

R. D. Long

G. A. Goerner, traveling storekeeper of the Chicago, Burlington & Quincy, with headquarters at Chicago, has been promoted to purchasing agent of the Colorado & Southern (a unit of the Burlington System), with headquarters at Denver, Colo., to succeed William C. Weldon, deceased. Hal D. Foster, inspector of stores on the Chicago, Burlington & Quincy, has been appointed traveling storekeeper, with headquarters at Chicago, to succeed G. A. Goerner.

Obituary

Percival Hunter, purchasing agent of the Chicago, Burlington & Quincy, with headquarters at Chicago, died in that city on February 3, of heart failure.

Charles D. Van Schaick, retired combustion expert for the New York Central, died at his home on Shippan Point, Stamford, Conn., January 19, after several weeks' illness. He was seventy-three years old. Mr. Van Schaick was a mechanical engineer. At the Rogers Locomotive Works, Philadelphia, he helped build the first locomotives for the West Shore. He helped build the motive power for the Mexican National Railways and spent some time in Mexico, demonstrating the power to the Mexican enginemen when it was put into service. Returning to New York, he entered the employ of the New York Central & Hudson River in 1890, and retired in 1932, since which time, however, he had done special work on assignment for the railroad.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

Tantalum.—The Fansteel Metallurgical Corporation, North Chicago, Ill., has issued a 48-page illustrated book in which technical information about tantalum and its uses are discussed. Tantalum is described as "A rare metal with amazing properties of heat and electrical transference—with unbelievable resistance to the destructive forces of acid corrosion, oxidation and wear."

Electric Welding Products. — Electrodes, arc welding machines and miscellaneous electric welding products, such as helmets, face shields, gloves, etc., are described and illustrated in the 32-page catalog issued by the Air Reduction Sales Company, Lincoln building, New York. A group of tables, especially useful to the welder, are contained in the last section of the catalog.

Brake Shoe Engineering and Research Facilities.—The Sargent Research Laboratory, of the American Brake Shoe & Foundry Co., Mahwah, N. J., describes and illustrates in a four-page bulletin its laboratory which is being equipped with a specially designed brake-shoe testing machine with recording instruments for the testing of brake shoes at maximum train speeds of 160 m.p.h. and wheels loads equivalent to a car weighing 320,000 lb. Mention also is made of their new metallurgical research laboratory, with experimental foundry and machine shop, and modern equipment for chemical and physical testing and heat-treating.

Haynes Stellited Valves.—Haynes Stellited valves for high temperatures and pressures, or for service where corrosion and erosion are encountered, are illustrated and described in an eight-page booklet issued by the Haynes Stellite Company, 205 East Forty-second street, New York.

Metal Coating Process.—The Metals Coating Company of America, 495-497 North Third street, Philadelphia, Pa., has issued File Folders Nos. 1203 and 1204, each of four pages, the former describing the complete molten metal spraying system and the latter describing in detail and illustrating complete MetaLayeR operating equipment.

Ball Bearings and Heavy Duty Roller Bearings.—A comprehensive review of the principles affecting the selection, application and operation of antifriction bearings, and ball bearings in particular, has been prepared by the Fafnir Bearing Company, New Britain, Conn., in the form of a wire-bound engineering manual, No. 35. The book is divided into five sections, and is available to executives and engineers responsible for bearing selection or maintenance.

MARINAC'S RAIL ODDITIES

Marinac has furnished us with the following explanations of the three cartoons which appear elsewhere in this issue.

Page 109. George Krahan received contusions of the right chest in a most unusual accident, which occurred in Fresno, Cal. One of the tires of his car was in some way forced off the wheel as a locomotive was approaching. It struck the locomotive sidewise and rebounded, hitting the driver.

Page 128. The cartoon is self-explanatory. The so-called railroads are of course, quite limited in length, but possibly the term "railroads" can be justified.

Page 129. A quaint village on the Isle of Anglesey, North Wales, boasts of the longest name in that country. It is composed of the following 58 letters: Llanfairpwllgwyngyllgogerychwyrndrobwll-Llantysiliogogogoch. Because of its unusual length the natives call it Llangfair P. G. for short. The illustration shows the railroad station sign being taken down in November. It is removed with great care and stored safely until spring.

Railway Mechanical Engineer

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With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic. Name Registered, U. S. Patent Office

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Pennsylvania

Streamline Steam Locomotive

THE Pennsylvania has recently turned out from the Altoona shops a Class K4s Pacific type locomotive and tender which has been completely streamlined by cowling over the boiler and skirting which extends down from the running board and around the front of the locomotive. The cab is faired into the lines of the locomotive, and the tender has been made to continue the lines of the locomotive by curved sides above the top of the tender, which conform to the sides of the cab roof. The top of the tender is not enclosed. The bottom of the skirting and tender form an unbroken line with the bottom of the coach sides when the locomotive is coupled to a train.

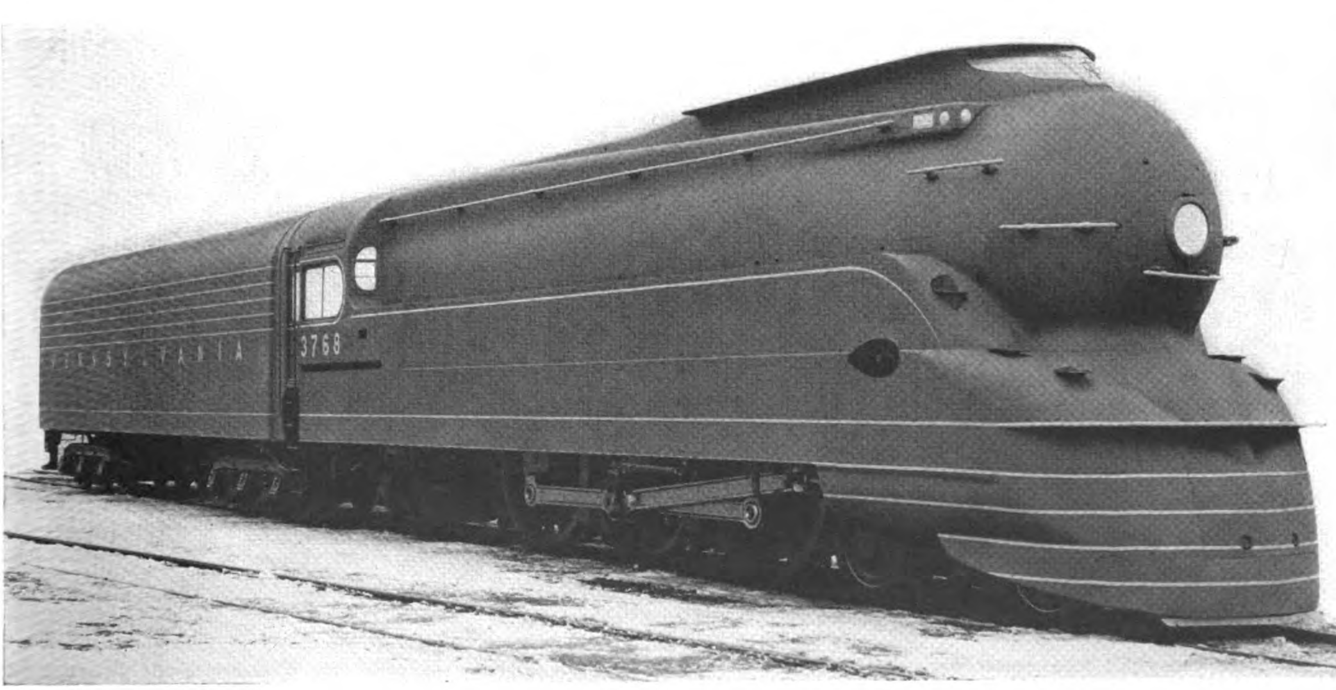
An outer diaphragm of heavy sheet rubber closes the space between the front of the tender and the rear of the cab, which is entered by side doors at the gangway behind the enginemen's seats. This diaphragm, which is put up under tension, provides a smooth, continuous surface between the engine and tender while standing on straight track, and stretches as much as is necessary to conform to the relative movement between the engine and tender on curves.

The body color is a gun metal tone against which the striping stands out sharply. The letters and the stripes on the tender and around the cab windows are in gold. The stripes on the engine are stainless steel, as are also the handrails on the sides and front end and the winged keystone emblem on the cowling in front of the stack.

By the separation between the front end of the boiler and the skirting in front of the pilot and around the cylinders the characteristic appearance of the steam locomotive has been retained. Aside from its pleasing appearance this separation is said to reduce the tendency to develop low-pressure pockets along the sides of the boiler at the front of the cab, which is characteristic of the so-called shovel-nose form. A further division of the air stream toward the same end is effected by a horizontal plane projecting around the front end of the locomotive at approximately front deck-plate height.

The smoke-lifting device consists of the stack cowling, enclosing a space of considerable width at the sides of and behind the stack, which is closed at the top by a horizontal plane flush with the top of the stack and extending somewhat beyond the cowling at the front and sides. Along each side of the boiler, starting with the enclosure for the classification lights at the front is a plane, the lateral elements of which are horizontal, which slopes upward toward the rear and blends into the contour of the cab roof. The space between each of these planes and the under side of the projecting horizontal plane is thus narrowed toward the rear, tending to produce a slight increase in air pressure and velocity at the rear end of the horizontal plane. This is said to remove all tendency for smoke to trail along the top of the boiler and the lateral component of the increased pressure in the air stream between the two planes is also a factor in reducing low-pressure spots along the side of the boiler toward the front of the cab.

The front end of the locomotive is completely equipped with a coupler and both brake and signal hose connec-



tions. When not in use the coupler is swung back horizontally and the hose connections are dropped into place behind the contour of the skirting which is closed by a panel permanently attached to the locomotive and which moves up and back within the skirting when opened.

The boiler cowling and cab are fabricated of sheet steel. The skirts below the running boards are of aluminum sheets. A long panel of each skirt is arranged to be completely removed by removing a few bolts when access to the rods and motion work is required in the enginehouse or shop. Doors have been provided at points where access for lubrication is not otherwise available. The smokebox and smokebox front have been lagged to protect the cowling from the heat. Openings in the cowling are provided over the whistle and pops, the location of which has not been changed. The sand box, however, has been moved forward immediately behind the stack. The bell is mounted on the engine frame under the cowling at the front of the locomotive.

The tender has 18,000 gal. capacity. The water tank is provided with two longitudinal filling holes, one in each side. The panels in the curved extensions of the tender sides opposite these openings are arranged so they may be unlatched and rolled laterally toward the center of the tank to clear the filling holes.

The locomotive as altered has a weight in working order of 337,850 lb. and the weight of the tender loaded is 289,700 lb. The overall length is 95 ft.

The design of the streamlining was developed by the railroad's engineering department in co-operation with Raymond Loewy, New York, an authority on streamlining and a member of the road's technical advisory staff. In working out the final design tests were carried on over a period of months in the wind tunnel of the New York University aerodynamic laboratory. Instead of the usual type of wood or metal models, clay models were used for the first time in these experiments. They demonstrated their superiority over the other materials because of the readiness with which shapes could be altered immediately upon observing the results of each test. Observations of air flow were made by the use of both silk threads and smoke bombs.

The comparative wind-resistance tests were made with models of the locomotive, tender and one coach. Under these conditions at wind-tunnel speeds of 100 m.p.h. the air resistance was reduced from 896 hp. with a conventional locomotive to 600 hp. with the streamliner.

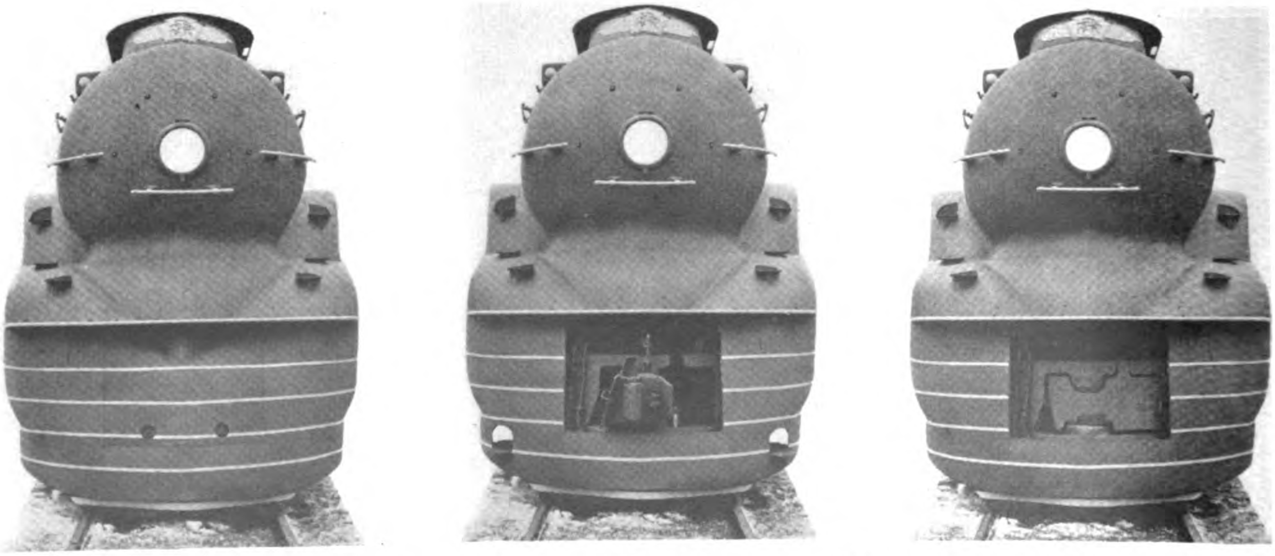
Roller-Bearing Journal Box with Lateral-Motion

With the application of roller bearings to locomotive driving axles the Franklin Railway Supply Company, New York, one of the first to provide controlled lateral for locomotive driving axles, became interested in developing a means of applying this principle to roller-bearing journal boxes.

On locomotives with plain crown-bearing journal boxes the control and cushioning of lateral motion has been largely confined to one or two axles for the primary purpose of keeping the rigid wheel base within practical limits on locomotives with long coupled wheel bases. In the case of the roller-bearing journal box, however, because of the absence of lateral motion within the bearing itself there is to be considered the added function of providing some cushioned lateral movement within the parts of the journal box to protect the axle bearing, frames and parts from shocks received through the track. To meet these conditions this company has developed a type of lateral-motion journal box which is adapted to either self aligning or radial type roller bearings and is applicable on either inside or outside journal bearings, the latter including those on trailer, tender and passenger-car trucks.

For both types of bearings the complete lateral motion journal box consists essentially of an inside box which houses the roller bearing and an outside box which fits into the pedestal of the locomotive or truck frame or is otherwise attached to the truck frame. The inside box conforms to the outside of the roller-bearing assembly and is essentially cylindrical in form. Within it are provided the necessary seals for retaining the roller-bearing lubricant. On the top of the inside box is doweled the spring seat or the spring-saddle seat, as the case may be. The outside box is open on the side next to the wheel hub and, in assembling, is slid onto the inner box in a direction parallel to the axis of the journal. The top of the outer box is also open for the doweled seat of the inner box on which the load is carried.

Lubrication of the sliding surfaces between the inner box and the driving box is provided from an oil pocket in the spring-saddle seat. Pockets in the top of the outer, or driving box, feed oil to the pedestal shoe and wedge faces. In the trailer box the oil pockets in the



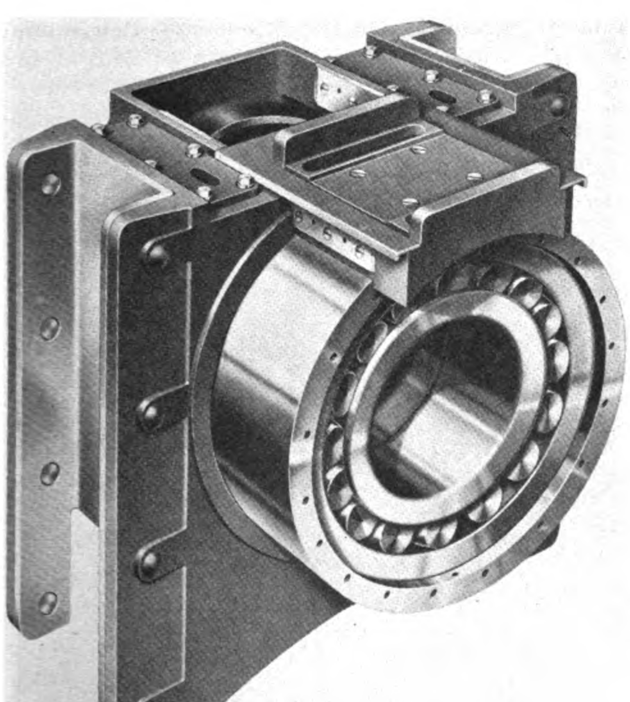
The brake and signal hose connections and the coupler are always ready for service—The panel rolls back behind the shrouding

outer box supply lubricant to both surfaces. Alemite fittings in the inner box extend through free openings in the closed end of the outer box.

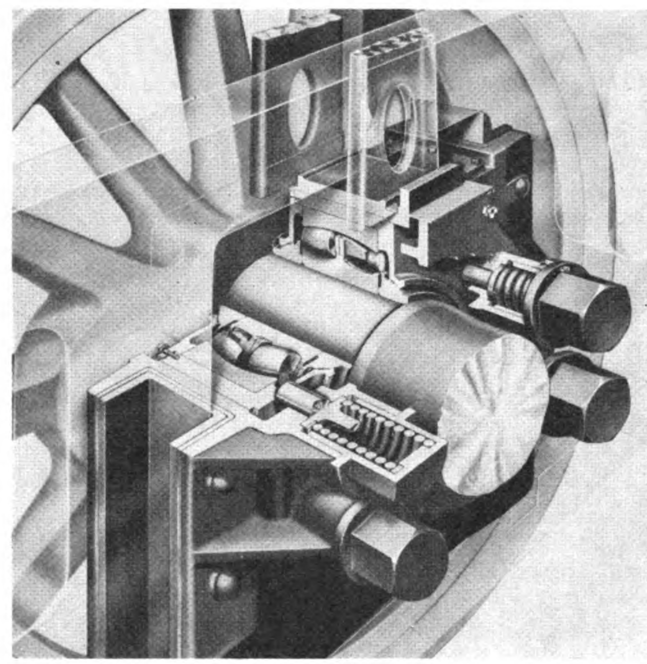
On the closed face of the outer box are a number of spring pockets which are parallel to the axle. Within each pocket is a coil spring which bears against a plunger projecting into the outer box toward the end surface of the inner box from which it is normally separated by a clearance of $\frac{1}{64}$ in. The lateral movement of the axle and the roller-bearing assembly with its inner box brings the latter into contact with the ends of the plungers in the outer box and builds up resistance against the movement by the compression of the springs. With the removal of the force causing the lateral movement of the axle the springs acting on the plungers restore the inner box to its normal or central position within the outer box.

The illustrations show a driving box designed for SKF self-aligning bearings. With this type of bearing the movement required to accommodate the variable inclinations of the axle with respect to the frames takes place within the bearing itself, and full-length bearing surfaces between the flanges of the outer or driving box and the pedestal shoe and wedge surfaces can be maintained. The only friction load on the sliding surfaces between the inner and outer boxes is what may be imposed by braking reactions and, in the case of driving boxes, by the piston thrust. The main bearing load is carried directly on the inner box.

With a journal box of this kind it is possible to provide the amount of lateral cushioning force desirable on any particular axle, depending upon its location in the wheel base. By the number of cushioning springs built into the box and the initial load adjustment the amount of resistance can readily be developed to supplement the resistance of the leading truck or the trailing truck in any proportion to provide proper riding quality both at speeds and on curves. In the case of the drivers it can also be varied to meet the conditions of location and, hence, to provide the proper flexibility in order to negotiate curves and overcome the disadvantages of a too long rigid wheel base. The cushioning of the lateral not only tends to increase the life of the mechanism, including flanges, wheels, axles, bearings and boxes, but also reduces stresses on the rail and roadbed. By reducing flange clearance it would be possible with journal boxes of this type to replace what is in reality a free lateral movement between the flange and the rail with a cushioned and controlled lateral movement within the lateral-motion journal box.



The inner box, with its inside cover removed, partially inserted in the outer box—When completely assembled all bearing surfaces are protected from dust



Lateral-motion roller-bearing driving box cut away to show the relation between the parts

Journal boxes of this type have been in service on the front driving boxes and the front trailer boxes of two Delaware, Lackawanna & Western 4-8-4 type locomotives since December, 1934, one of these locomotives operating largely in passenger service and the other largely in freight service. In this installation the maximum lateral permitted within the driving boxes is ⅝ in. and within the trailer boxes, 1 in. Observations made by the use of Bowden wires attached to one plunger each in a driving box and a trailer box indicate that in approaching a curve the lateral-motion boxes permit the axle to adjust itself smoothly and gradually and no side sway of the locomotive was evident either on tangent track or on curves due to a jerky lateral movement of the axles. When operating in the yard and in pusher service the lateral movement within the driving boxes varied up to a maximum of ¼ to ⅜ in., both in forward and backward motion. In backward motion the springs in the trailer box were compressed ⅝ in. under conditions of severe curvature, and in forward motion not more than ⅜ in. Examination of the boxes, however, indicates that at times there have been lateral movements up to the maximum permitted by the design of the boxes. In road passenger service a reduction in the initial lateral force on the trailer boxes from 31.6 per cent to approximately 21 per cent of the wheel load was found to effect a smoother operation of the trailer. The initial force in the driving box has been maintained at 31.6 per cent of the wheel load.

Horsepower and Grate Area

By Paul T. Warner

Formulas for evaporation and boiler horsepower apply only when sufficient grate area is provided

IT is a generally recognized fact that the true measure of a locomotive's capacity is the horsepower that it is capable of developing at various speeds. A statement covering tractive force means nothing unless the speed at which that tractive force is exerted is included. The product of the two is directly proportional to the horsepower.

It is also recognized that the factor which primarily determines the maximum horsepower that a locomotive can exert is the steaming capacity of the boiler. Locomotives are invariably proportioned so that, except at slow speeds, the cylinders can utilize all the steam that the boiler produces; hence, while the efficiency with which the steam is utilized is of importance in determining the indicated horsepower, the factor first to be considered is the boiler. This is evident in all the tentative methods for determining locomotve horsepower that have been worked out during recent years. The best known of these is probably that developed by F. J. Cole and published by the American Locomotive Company in 1914. This method is used as the basis for that recently presented by A. I. Lipetz before the American Society of Mechanical Engineers and which Mr. Lipetz uses in determining the horsepower of a number of recent high-capacity locomotives.

Table I—Factors of Evaporation for Firebox and for Tubes and Flues of Varying Lengths

FIREBOX:—Allow an evaporation of 55 lb. per sq.ft. of heating surface per hour for ordinary fireboxes, including combustion chamber, arch tubes and thermic syphons. Test data for watertube fireboxes are meagre; a tentative rate of 42 lb. has been proposed.

FEEDWATER HEATER:—If locomotive is equipped with a feedwater heater or an exhaust steam injector, multiply the calculated total evaporation by 1.08.

Tube length, ft.	Evaporation, lb. per hr.	Tube length, ft.	Evaporation, lb. per hr.
10.0	13.00	18.0	9.85
10.5	12.75	18.5	9.70
11.0	12.55	19.0	9.50
11.5	12.30	19.5	9.35
12.0	12.10	20.0	9.20
12.5	11.80	20.5	9.05
13.0	11.65	21.0	8.95
13.5	11.45	21.5	8.80
14.0	11.25	22.0	8.65
14.5	11.10	22.5	8.55
15.0	10.90	23.0	8.40
15.5	10.70	23.5	8.30
16.0	10.50	24.0	8.20
16.5	10.35	25.0	8.20
17.0	10.20	26.0	8.20
17.5	10.00		

The Baldwin Locomotive Works has presented, in its quarterly magazine "Baldwin Locomotives," a method developed by Thos. R. Cook for determining what is called the "potential horsepower" of a locomotive. In many respects this follows the well-known Cole method, but it is easier to apply as it uses only data that can be readily obtained, while the Cole method is based partly on the spacing of the boiler tubes, which usually cannot be obtained without a print of the boiler. In utilizing the Cook method the amount of steam that the boiler is considered capable of producing per hour is first calculated and this amount is then divided by a factor representing the assumed steam consumption per horsepower-hour. The result gives the horsepower that the locomotive is capable of developing, except at slow speeds when the cylinders cannot utilize all the steam that the boiler is capable of producing.

In figuring the boiler output it is assumed that 55 lb. of water can be exaporated per hour for each square foot of heating surface of the ordinary firebox, including combustion chamber, arch tubes and syphons, and that the tube and flue heating surfaces will evaporate amounts varying with the length of the tubes, as given in Table I. An additional evaporation of 8 per cent is assumed if a feedwater heater is applied. As the test data from boilers with water-tube fireboxes are quite meagre, the evaporative factor for such fireboxes can not be taken with any certainty. A tentative rate of 42 lb. per square foot per hour has been suggested. It is also assumed that sufficient coal can be burned on the grate to evaporate these amounts of water. The assumed steam consumption per horsepower-hour for different pressures and degrees of superheat is given in Table II.

Table II—Steam Consumption Factors for Determining Potential Horsepower

Steam pressure, lb.	Pounds of steam for potential horsepower-hour			
		Degrees of superheat and type of superheater		
	Saturated steam	150 Type A, small	200 Type A, large	250 Type E
150	29.75	22.40	21.30	29.25
155	29.60	22.20	21.10	20.00
160	29.30	22.00	20.85	19.80
165	29.10	21.85	20.75	19.70
170	29.00	21.75	20.60	19.50
175	28.75	21.65	20.40	19.30
180	28.60	21.45	20.25	19.20
185	28.40	21.30	20.10	19.05
190	28.30	21.25	19.90	18.90
195	28.10	21.10	19.80	18.80
200	28.00	21.00	19.70	18.70
205	27.80	20.90	19.60	18.60
210	27.75	20.80	19.50	18.50
215	27.60	20.70	19.40	18.40
220	27.50	20.65	19.30	18.30
225	27.40	20.55	19.25	18.25
230	27.30	20.50	19.10	18.20
235	27.20	20.45	19.05	18.15
240	27.10	20.35	19.00	18.10
245	27.00	20.25	18.90	18.00
250	26.90	20.20	18.85	17.95
255	26.85	20.15	18.80	17.90
260	26.80	20.10	18.75	17.85
265	26.75	20.05	18.75	17.80
270	26.65	20.00	18.75	17.80
275	26.60	20.00	18.75	17.75
280	26.55	19.95	18.70	17.75
285	26.50	19.90	18.70	17.75
300	26.45	19.85	18.65	17.70
325	26.40	19.80	18.65	17.70
350	26.35	19.80	18.65	17.70

1—Allow 150 deg. F. added by Type A superheater—small or original design—where the number of tubes divided by the number of flues is greater than six.

2—Allow 200 deg. F. added by Type A superheater—large or improved design—where the number of tubes divided by the number of flues is less than six.

3—Allow 250 deg. F. added by Type E superheater.

As this method covers a wide range of tube lengths, steam pressures and degrees of superheat, the author

recently applied it to a large number of locomotive designs in order to determine not only their relative efficiency, but also whether they had grates of sufficient size to generate the amounts of steam required by the formula. The general results of this study, which proved most interesting, are presented in this paper. All the locomotives considered are of the two-cylinder, single-expansion type, with fireboxes of conventional design, suitable for the use of bituminous coal as fuel. They were selected more or less at random, but are representative of the motive-power practice of their respective periods, and no designs that could in any way be regarded as "freaks" were included.

Relation of Firing Rate to Evaporation

The first step in this investigation was to determine a definite relationship between the rate of firing per square foot of grate per hour and the evaporation per pound of coal burned. This relationship is shown in Fig. 1. The curves here presented—one of which applies to locomotives using saturated steam and the other to locomotives equipped with superheaters—are based chiefly on Pennsylvania tests and on information presented by F. J. Cole before the New York Railroad Club on November 21, 1901. The curves are, of course, only approximations, as locomotive boilers show widely different results in water evaporation at various rates of firing, but for the purpose of comparison they are reasonably satisfactory. No two persons, working independently, would produce curves of this kind that would show exactly the same results, and it is impossible, without actual tests, to determine the exact amount of water per pound of coal that any given boiler will evaporate.

It early became evident that locomotives fitted with superheaters and saturated steam locomotives with wide fireboxes would, when burning coal of reasonably good quality, develop their potential horsepowers at firing

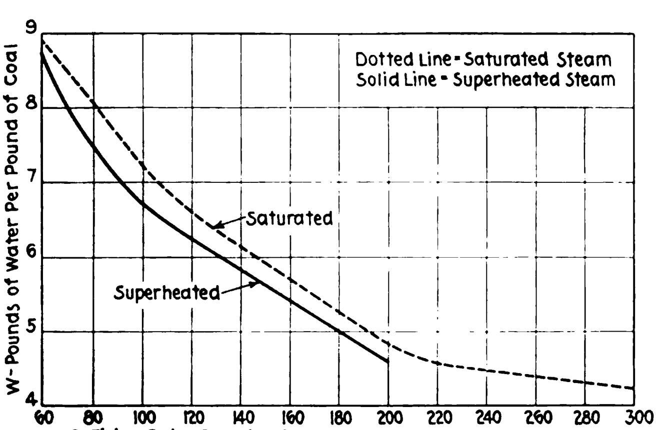


Fig. 1

rates well under 200 lb. an hour, but that many locomotives with narrow fireboxes would show very much higher rates. Accordingly, the curve for saturated steam locomotives was extended to show an evaporation of 300 lb. per square foot of grate per hour. This extension of the curve is open to criticism, as there are very few locomotive boilers in which it would be possible to burn coal at such a high rate. Furthermore, when boilers are being unduly forced, the actual evaporation frequently drops off even with an increase in the rate of firing. A 300-lb. rate, however, has been reached on the Altoona plant in a 4-8-2 type superheated locomotive having a comparatively moderate amount of grate area, but a large combustion chamber and furnace volume. By extending the curve to 300 lb., it has been possible to include in the study a considerable number of narrow firebox locomotives which would otherwise be entirely outside the range of calculation.

For any given boiler the firing rate, when developing full potential horsepower, is largely dependent upon two factors—the number of square feet of heating surface per square foot of grate area, and the equivalent evapora-

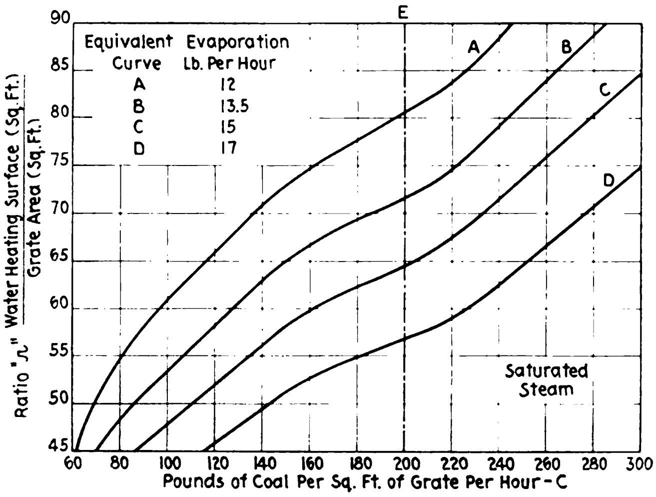


Fig. 2

tion rate per square foot of heating surface. The latter factor is obtained by dividing the total calculated evaporation per hour by the total evaporative heating surface. It is evident that increasing the firebox heating surface in proportion to the total, or reducing the length of the tubes, will increase the equivalent evaporation rate.

Ratio of Heating Surface to Grate Area

The relation between evaporation per pound of coal and the rate of firing (Fig. 1) having been determined, two sets of curves—one (Fig. 2) for saturated and one (Fig. 4) for superheated locomotives—were plotted to show the relation between ratio of heating surface to grate area and coal consumed per square foot of grate per hour for different rates of equivalent evaporation. These cruves are based on the following equations:

Let

g = grate area in square feet
h = water heating surface (total) in square feet
e = equivalent evaporation in pounds per hour per square foot of heating surface
w = pounds water evaporated per pound of coal
c = firing rate (pounds of coal per square foot of grate per hour)
r = ratio of h to g

Then

$$h \times e = \text{pounds water evaporated per hour} = g \times c \times w$$

Hence

$$c = \frac{h \times e}{g \times w}$$

and if we let

$$\frac{h}{g} = r$$

$$c = r \times \frac{e}{w}$$

For any given locomotive the value of e should first be determined by calculating the total evaporation in pounds per hour and dividing this figure by the total evaporative heating surface. A value for w must then be selected, by the "pick and try" method, that agrees with the corresponding value for c as given in Fig. 1. Thus, let it be assumed that in the case of a certain

locomotive using saturated steam the value for *r* is 60 and for *e*, 12. Then $c = \frac{720}{w}$. If we assume a value of 120 for *c*, the corresponding value for *w*, as gvien by the formula, will be 6.0. Fig. 1, however, shows that with a firing rate of 120 lb. the corresponding evaporation, using saturated steam, is 6.6 lb. If now the firing rate is assumed to be 100 lb., the corresponding evapora-

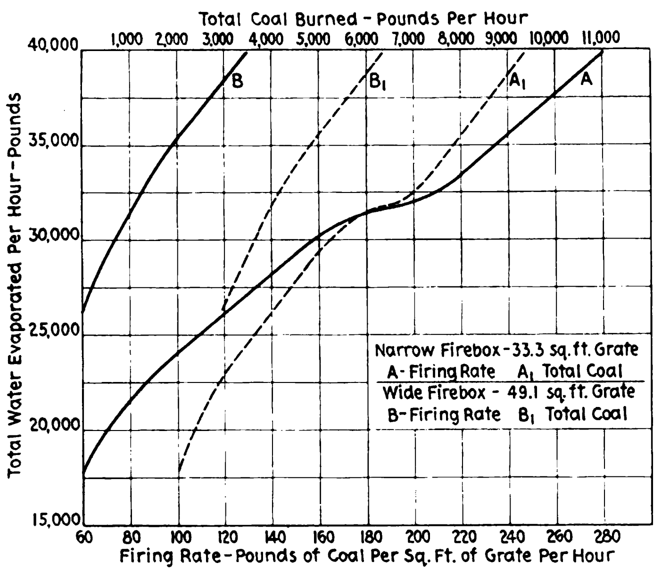


Fig. 3

tion, as given by the formula, is 7.2 lb. This agrees with Fig. 1 and, therefore, 100 and 7.2 are the correct values for the locomotive in question. If the locomotive uses superheated steam and has a value of 50 for *r* and 15 for *e*, the formula becomes $c = \frac{750}{w}$. If we assume a firing rate of 110 lb., the corresponding evaporation, as given by the formula, is 6.8 lb., whereas Fig. 1 shows an evaporation at this firing rate, of 6.5 lb. If, however, we assume a firing rate of 120 lb., the corresponding evaporation, as given by both the formula and Fig. 1, is 6.25 lb. These values should, therefore, be used.

It is evident that if the value of *w* corresponding to any selected value of *c*, as given by the formula, is less than the value given by Fig. 1, then the firing rate should be reduced in order to equalize the two; whereas, if the formula shows a higher value for *w* than does the curve in Fig. 1, then a higher value of *c* should be tried. With a little practice and with fixed values, in any given case, for *r* and *e*, the corresponding values for *c* and *w* can readily be found.

Due to differences in the values of *e*, two locomotives with practically the same *r* values may show surprising differences in the firing rates. This is illustrated in the case of the two engines considered in Table III.

Table III

Engine	Firebox heating surface in per cent of total	Values of r	e	c
A	5.35	60.5	11.6	94
B	10.90	59.8	17.3	230

Engine *A* is a wide firebox 4-6-2 type using saturated steam, while engine *B* is a 4-4-0 type of the period of 1872, with a deep firebox between frames and driving axles and tubes only half the length of those in engine *A*. Engine *A* should have no difficulty in developing horsepower as calculated by the Cook formula, but it is very problematical as to whether sufficient coal could be burned in the small firebox of engine *B* to make a similar performance possible.

Narrow Fireboxes

Of the heavy narrow firebox locomotives investigated, built during the nineties and early in the present century, very few were found in which the firing rate when developing full potential horsepower would be less than 200 lb. per square foot of grate per hour. The average firing rates and the values of "horsepower divided by grate area" for three representative types were found to be as shown in Table IV.

Table IV

Type of locomotive	No. of locomotives	Firing rate, average	Horsepower Grate area
4-4-0	17	249	39.0
4-6-0	24	248	39.3
2-8-0	14	236	37.5

In a number of instances the firing rate was far in excess of 300 lb., entirely beyond the limit of the curve

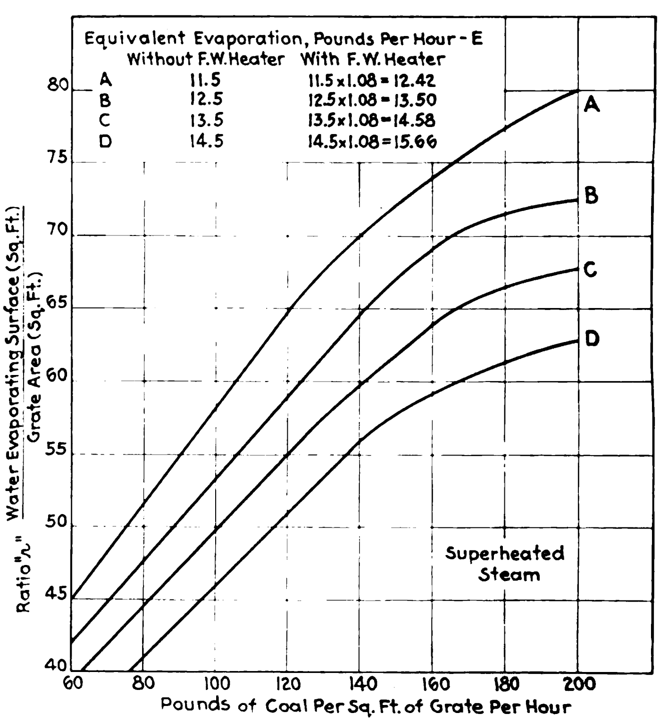


Fig. 4

shown in Fig. 1. Table V gives data covering some of these locomotives. The "potential" horsepower is that calculated from the formula, while the "probable maximum" horsepower is based on an assumed firing rate of

Table V

Engine	Type	Values of r	e	Horsepower Grate area	Horsepower Potential	Probable maximum
C	4-4-0	90.2	15.8	50.2	940	620
D	4-4-0	100	15.8	53.8	985	595
E	4-4-0	89.5	15.4	48.3	1,220	835
F	4-6-0	107	15.5	57.3	1,020	585
G	4-6-0	96	13.9	47.5	1,445	1,035
H	2-8-0	103	13.7	51.5	1,895	1,270
I	2-8-0	99.5	13.6	48.2	1,615	1,140
J	4-8-0	93.5	14.3	48.2	1,805	1,285
K	4-8-0	96.5	14.4	50.2	1,705	1,165

200 lb. and an evaporation of 4¾ lb. of water per pound of coal, as taken from Fig. 1. The steam consumption per horsepower-hour is then taken from Table II.

Engines *C*, *D* and *F* had narrow fireboxes between the frames and driving axles, while the other locomotives had long fireboxes placed above the frames but between the wheels. The most abnormal case is engine *F*, in which the probable horsepower is only 57.4 per cent of the potential.

It is probably safe fo say that the heating surface should not be used as a basis for horsepower calculation in any locomotive in which the firing rate exceeds 200 lb. In many locomotives it would be impossible to force the rate of combustion even to that figure. A heavy vertical line *E* in Fig. 2 divides the diagram into two parts, that on the left covering locomotives which come within the 200-lb. limit and that on the right those, including the majority with narrow fireboxes, that exceed this limit.

The wide firebox, saturated steam locomotives, show firing rates that are far more favorable. Table VI presents particulars of 75 locomotives of four types:

Table VI—Saturated Steam

Type	No. of locomotives	Values of r	e	Horsepower / Grate area	Firing rate	Weight / Horsepower
4-6-0	14	60.0	13.6	29.0	128	131
2-8-0	26	59.8	13.5	28.7	128	133
4-4-2	19	62.4	13.2	29.4	134	126
4-6-2	16	69.8	11.7	29.3	129	147

In the items given in the last column of the table the weight of each locomotive in working order, but without tender, is that considered.

There is a marked similarity in the firing rates of all four types and also in the amount of horsepower developed per square foot of grate area. The 4-6-2 type, with its long tubes, shows a considerably lower equivalent evaporation than the other three and also a higher weight per horsepower. The minimum and maximum firing rates for the different types are as shown in Table VII.

Table VII

Type	Minimum	Maximum
4-6-0	112	155
2-8-0	81	192
4-4-2	81	177
4-6-2	94	167

To illustrate more clearly the effect which the amount of grate area has on the firing rate and the evaporation, Fig. 3 is presented. The curves are based on two saturated steam locomotives built for the same road, and practically duplicates of each other, except that one had a narrow, and the other a wide, firebox. Characteristics of these locomotives are given in Table VIII.

Table VIII

Firebox	Grate area	Total heating surface, sq.ft.	Evaporation, lb. per hour (Cook)	Values of r	e	c	Horsepower / Grate area
Narrow	33.3	2,812	39,900	84.5	14.2	282	43.3
Wide	49.1	2,844	39,600	57.8	13.9	124	29.0

Although, due to the distribution of the heating surface, the maximum estimated evaporation with the narrow firebox is slightly greater than with the wide, it is very questionable whether the rate of firing in the first locomotive could be forced sufficiently to produce the evaporation called for. It is interesting to note that with a total coal consumption of (say) 5,000 lb. an hour, the wide firebox boiler evaporates 20 per cent more than the other. No wonder that the use of the wide firebox proved a relief to the fireman as well as to the railroad manager.

Superheated Locomotives

Particulars covering 125 locomotives using superheated steam are presented in Table IX. The locomotives fitted with feedwater heaters are separated from those not so equipped. In the case of the former, two rates for equivalent evaporation are given—one with the heater cut out and the other with the device in use. The increased evaporation due to using the heater is taken as eight per cent, in accordance with the Cook method of calculation. The potential horsepower is based on this higher value, but in determining the firing rate the lower value for *e* should be used.

Table IX—Superheated Steam

Type	No. of locos.	Feedwater heater	Values of r	e	Horsepower / Grate area	Firing rate	Weight / Horsepower
4-6-2	24	No	60.5	12.5	37.1	123	125
4-6-4	6	Yes	50.8	12.9 13.9	38.7	96	115
2-8-2	26	No	63.4	12.3	37.0	132	124
4-8-2	17	No	60.8	12.8	40.3	132	121
4-8-2	6	Yes	58.4	13.6 14.7	46.8	137	106
4-8-4	4	No	58.4	13.2	41.2	127	116
4-8-4	18	Yes	54.0	13.1 14.1	42.7	111	109
2-10-2	18	No	59.8	12.7	38.6	125	118
2-10-4	6	Yes	52.5	13.1 14.1	41.9	103	111

It is unfortunate that, in the case of a number of these types, there are very few representatives. Thus, the low average weight per horsepower of the 4-8-2 type locomotives with feedwater heaters is largely due to the fact that one of these designs weighs only 89.5 lb. per horsepower—the lightest, in point of weight per horsepower, of any of the locomotives investigated.

The firing rates in the locomotives covered by Table IX vary from a maximum of 78 lb. in the case of a 4-6-4 type, to 186 lb. in the case of a 2-8-2 type. Averaging the figures, the locomotives with two-wheel trailing trucks show a firing rate of 130 lb. as against 109 lb. for the locomotives with four-wheel trailing trucks—a reduction of 16 per cent in favor of the latter. Similarly, the locomotives without feedwater heaters average 121 lb. weight per horsepower as against 110 lb. for those with feedwater heaters. This represents a reduction of approximately 9 per cent.

Comparing the locomotives equipped with superheaters and feedwater heaters with the saturated steam, wide firebox locomotives previously discussed and in general use 25 years ago, the average weight per horsepower has been reduced from 134 to 110 lb., or approximately 18 per cent.

Fig. 4 shows the firing rates corresponding to different values of *r* and *e*, for locomotives using superheated steam. Each curve represents two values of *e*, depending upon whether or not a feedwater heater is used. For reasons previously explained, the maximum firing rate shown on the diagram is 200 lb. an hour.

A method of horsepower calculation, such as has been discussed, is of interest and value in comparing locomotives of different designs and in estimating the capacity of new power. It must be used wth some caution, however, especially in the case of the older narrow firebox locomotives where it is liable to give values for evaporation that are entirely beyond the capacities of the boilers.

Brakes for

Modern High Speed Trains*

By L. K. Sillcox†

Improvements made in air brakes to meet new conditions—Other possible types of train brakes are considered

NO mere increase in the physical capabilities for speed can be considered adequate to the needs for high-speed operation on the railways. Attention must be given all elements of operating practice and all details of the railway facilities which are affected by speed, foremost among which are signalling and braking. Consideration of signalling and braking are so intimately related to the speed of the units over which they must exercise control that it is impossible to deal with the problems imposed by modern and prospective train speed without giving passing thought to these vital elements without the parallel development of which, ever higher speeds could not be safely attempted.

Increased maximum train speeds have introduced the necessity for amplification of the type of brake equipment heretofore furnished and the newer designs have provided for reductions of at least 60 per cent in the length of stops from ultra high speeds.

Adhesion Between Wheel and Rail

As a wheel rolls freely upon a rail, there is no relative movement between wheel and rail at the point of contact. In fact, the wheel occupies a minute depression in the rail since, under normal wheels loads, there is a measurable distortion of both wheel and rail. Since the wheel-rail contact is normally static, the same frictional resistance to rotation of car wheels is required throughout the entire speed range to induce them to slide upon a dry rail.

It is a simple matter to measure the coefficient of wheel-rail adhesion when the wheel is at rest, the coefficient of wheel-rail adhesion being defined as the factor which, multiplied by the weight upon the wheel, defines the force applied tangent to the wheel at the point of contact, which resists movement of the wheel along the track without rotation. It is more difficult to determine its values as speed increases since many variables are introduced by conditions of weight transfer imposed by imperfect track surface, the interaction of different parts of the equipment, the effect of lateral forces imposed by guiding, and the vertical oscillation of car bodies and other sprung weights upon the yielding suspension system. Since it is impracticable to attempt to measure the instantaneous values of these variable forces or their resultant, the adhesion coefficient can best be determined by obtaining the average of results of repeated trials. Tests have now been conducted which verify the maintenance of the static value of approximately 0.25 under dry rail conditions for the coefficient, independent of speed. Although the behavior of this single factor with increasing speed has been established as constant, it is the product of the weight supported and the coefficient of wheel-rail adhesion which resists wheel sliding and, as speed increases, the influence of irregularities in the surface of the track increases in like proportion to the end that, upon encountering any slight obstruction, the vertical acceleration of the wheel and car body is higher with a greater momentary wheel load, and a subsequent greater reduction in the weight supported. During this brief interval a high brake retarding force may decrease the rate of rotation, causing slipping of the wheel upon the rail and, once started, a condition of sliding can be continued with a lower wheel retarding force than otherwise since, after slipping occurs, the coefficient of wheel-rail adhesion is no longer static but kinetic and if rotation is arrested, the coefficient of brake shoe friction is no longer kinetic but assumes its higher static value. For this reason, the surface of track over which heavily braked, high-speed trains operate must be carefully maintained and the spring suspension system arranged to insure, as far as possible, a uniform and constant load upon the rails.

Brake-Shoe Friction

There is another very important phenomenon to be considered in any enlightened approach to the problem of high-speed braking. While tests have proved the existence of a constant coefficient of wheel-rail adhesion, the variable nature of the kinetic coefficient of brake-shoe friction has also been established. Its value decreases as brake-shoe pressure increases and is further diminished with each increment of speed increase. In view of these facts, it has been customary to so limit the maximum brake-shoe pressure that the friction developed at low speed should not be sufficient to cause injurious wheel sliding. The total friction at any instant is the direct measure of the resistance which is then retarding the motion of the train and, therefore, a uniform brake-shoe pressure offers much less resistance to the motion of a high-speed train at the beginning of a stop than at the subsequent low speed. It is for this reason that a greater brake-shoe pressure may be applied to the wheels at high speed than at lower rates of travelling without causing them to slide. This has been the principle respected in the formulating of all high-speed brake designs.

Types of High Speed Brakes

The first approach to this variable shoe pressure problem obtained a diminishing brake-shoe pressure value as the retardation cycle progressed by the use of a reducing valve, adjusted to relieve brake-cylinder pressure at a predetermined rate, whereas the more modern basis has been that of using an inertia governor, not subject to any time element but responsive only to the longitudinal inertia effect of the train when being brought to a stop.

The brake which was fitted with a high-speed reducing valve was essentially a quick-action air brake operating under high pressure. In emergency applications it first created a high brake-cylinder pressure and this was gradually and automatically reduced as the speed de-

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† Vice President, The New York Air Brake Company.

creased. This scheme offered no selection of change in brake cylinder pressure with initial speed or other conditions which might affect the stop and did not permit utilization of maximum retarding force at any time. Obviously, since the coefficient of brake-shoe friction varies in a very definite and reliable manner with the rubbing speed of the brake shoe over the wheel tread, an attachment at the axle to measure the change in the factor causing variation in retarding force could be the only practicable alternative for the inertia principle which measures the effect of brake-shoe friction variation and automatically adjusts the mechanism to preserve the effect at a predetermined level. The control device employed consists of a housing within which a heavy weight is mounted in such a maner that it is permitted displacement in the direction of car movement. With its movement from normal position resisted by carefully calibrated springs, a force of known intensity will change its position by a predetermined amount. Upon initiation of a brake application, the brake cylinders of the car, the retardation of which is under the automatic control of this device, will receive pressure, extending the pistons and pressing the brake shoes against the wheels. A rate of retardation is thus impressed upon the car which, if of sufficient magnitude to cause the weight to thrust forward against the opposing forces of the springs, brings the retardation-control device into action. The function of the weight is that of operating a valve or, indirectly, a circuit which gradually releases pressure from the brake cylinder if the rate of retardation attains a selected maximum. This rate, fixed by the factor of wheel-rail adhesion, cannot be exceeded without introducing the hazard of wheel sliding.

Limits to Retardation Obtainable

If the weight upon the wheels were constant at all times and rail conditions were always the same, the wheel-rail adhesion factor of 0.25 could be utilized to obtain a maximum rate of retardation. Since retardation is negative acceleration, the fundamental equation,

$$F = M a$$

can be used for determining the maximum rate of retardation which may be impressed. In the above equation,

F = retarding force in pounds
M = mass
a = rate of acceleration in feet per second per second

since

$$M = \frac{W}{g}$$

W = weight in pounds
g = acceleration due to gravity = 32.2 ft. per sec. per second,

the equation may be written

$$F = \frac{W a}{32.2}$$

Then, to determine the maximum permissible rate of retardation, *a*, which may be impressed with security from wheel sliding with coefficient of wheel-rail adhesion of 0.25,

$$a = \frac{32.2 F}{W}$$

With the weight, *W*, taken as unity, the equation reduces to,

$$a = 32.2 \times 0.25 = 8.05 \text{ ft. per sec. per sec., or } 5.50 \text{ m.p.h. per sec.}$$

Actually, a factor of 0.25 may not be available in every case or the weight on any axle may be momentarily relieved. In the interest of security from possible damage to the wheels, a coefficient of 0.16 is selected on no other basis than that of judgment governed by experience in high speed braking. The maximum retardation rate is then,

$$a = 32.2 \times 0.16 = 5.15 \text{ ft. per sec. per sec., or } 3.50 \text{ m.p.h. per sec.}$$

To the average railway mechanical officer, a suggested sustained retardation rate of 3.5 m.p.h. per sec., obtainable by the use of the pneumatic brake alone, would seem too optimistic to be seriously considered even though he is seeking a reduction in the minimum stopping distances to conform with the needs of the operating department. His hesitancy is due to a fear that the attempt to secure such a marked improvement, providing the stopping distances tabulated below, would be attended by undesirable features to the extent that the advantage of minimum stops would be more than offset by difficulties in other direction.

Stopping Distances Obtainable with a Retardation Rate of 3.5 M.p.H. per Sec., Sustained throughout the Duration of Stop. (Average Speed = 55 per cent Initial Speed).

Initial speed, m.p.h.	Stopping distance, ft.
100	2,300
90	1,870
80	1,470
70	1,130
60	830

If trunk-line railway speeds must be increased in any case beyond the point that stops effected with a 3.5 m.p.h. per sec. retardation rate are no longer satisfactory or do not fall within the limits imposed by signal spacing in localities where relocation would be particularly costly or would cause undue occupation of track by prevailing slower moving trains, or if any combination of circumstances arises which demands a still higher retardation rate than can be obtained by the use of the pneumatic brake alone within the limits of wheel-rail adhesion, some supplementary braking method must be adopted.

When a source of ample electrical energy supply is available, as when electric traction is employed, magnetic track brakes are suggested. If this is impractical or inadequate and if very high speeds are practiced, there are opportunities for shorter stopping distances presented by a wind resistance brake, an unproven expedient in-so-far as service tests are concerned but one which, producing the effect of increasing head-end air resistance, will be most effective in the early stages of a brake application from high speeds, offering a positive retarding force, independent of wheel-rail adhesion, which is subject to reasonable mathematical evaluation.

Magnetic Track Brakes

The magnetic track brake is less effective than is generally believed and its use entails features which render its application impracticable in many cases. When car equipment is light, traffic congestion serious, demanding maximum acceleration and deceleration rates, and an unlimited supply of electrical energy available, all of which are conditions common to the multiple-unit trains of important subway lines where the track brake has been most highly developed, the opportunities for justifying its cost, weight, and maintenance are much more favorable than on trunk-line railways.

In any consideration of a magnetic track brake, several important factors must be recognized. First, to obtain an efficient track brake with predictable characteristics, perfect contact between rail and shoe must be obtained, it having been demonstrated that a 21 per cent reduction in shoe-rail pressure results from the introduction of an air gap of but 0.0156 in. Perfect contact is impossible to maintain in railway work where both the gap and

force are widely variable. Second, the use of a track brake makes the use of sand impracticable since the abrasive action of a sanded rail introduces excessive wear on the shoes and, by wiping most of the sand off the rail, the shoes limit the permissible braking ratio which may be employed in connection with the wheel brake. Third, it is generally impossible to install sufficient length of track shoe, by reason of clearances between truck wheels, to provide a really effective track brake on any main-line railway equipment constructed to date. Fourth, the cost and weight of equipment required, including battery and generator, are disproportionately high. Fifth, there is no background of experience to define the measure of safety involved in thrusting track shoes upon the rails in front of wheels of units moving at high, main-line speeds.

A typical magnetic track brake shoe will exert a pull of approximately 300 lb. per inch of shoe length on a 130-lb. rail whenever perfect contact is obtainable throughout its length. This is obtained with an energy consumption of 50 watts per inch. Although unpredictable in view of the meagre data available, it is improbable that instantaneous contact conditions will provide more than 75 per cent of the vertical pull obtainable under conditions of perfect contact. This would mean a unit pressure of not more than 225 lb. per linear inch. If 60 in. of track shoe are installed per truck (120 in. per car or 720 in. per six-car train), the total pressure would be 162,000 lb. The coefficient of friction between track shoe and rail will probably seldom exceed a value of 0.07 throughout a stop from 90 m.p.h., in view of the very high unit pressure which may result from an equivalent magnetic attraction of 300 lb. per linear inch. It is further indicated that instantaneous values of 100 m.p.h. do not exceed 0.02. Assuming an average value of 0.07 throughout the stop from 90 m.p.h., the retarding force derived would be 11,345 lb. for the entire train. A retarding force of this order, however secured, is but 12 per cent of that obtained by the use of a standard pneumatic brake for conventional equipment, presenting a maximum emergency braking ratio of 150 per cent which, unassisted by an auxiliary brake, will provide an average retardation rate throughout the stop of 2 m.p.h. per second. Were a 3.5-m.p.h. deceleration rate impressed by a pneumatic brake, electrically operated to accelerate the response of the individual valves and with retardation rate automatically controlled, the effectiveness of the track brake would be but seven per cent of that of the pneumatic system. Furthermore, with an energy input of 50 watts per inch of shoe, or 6,000 watts per car, the current consumption, with a 32-volt system, will be at the rate of approximately 87 amp., requiring not less than 1,000 amp. hr. of battery capacity per car for all trains which do not derive their energy from a central source, remote from the train. Adding to the weight and cost of this battery the weight and cost of the generator required to serve it in the event that the train is not electrically propelled, and that of the mechanism itself which will add not less than 600 lb. per truck, the advantage to be gained will generally be more than offset by the cost involved and the extra weight required.

The Wind Brakes

The wind brake may be defined as an unexplored medium which may be properly employed in the control of trains operating at high speeds. It utilizes the air resistance force which modern high-speed trains are designed to reduce to a minimum. Head-end streamlining of a conventional steam locomotive can, by proper application as developed by model tests conducted by the National Research Council, reduce the coefficient of head-end resistance (K_a in the equation, $R_a = K_a AV^2$) from 0.0024 to 0.0015, where

Ra = head-end air resistance in pounds
Ka = coefficient of head-end air resistance
A = frontal area in square feet
V = speed in m.p.h.

The projected frontal area of a passenger-train car of conventional proportions is approximately 124 sq. ft. This will produce an air resistance force if streamlined to the extent that $K_a = 0.0015$, of 0.18525 V^2. If it were possible to present the equivalent of a flat surface of 160 sq. ft., nearly the maximum as defined by the A.A.R. clearance lines, normal to the direction of motion, to assist in decelerating from high speeds, the head-end resistance would be defined by the expression:

$$Ra = 0.00324 \times 160 \ V^2 = 0.518 \ V^2$$

Then, when $V = 90$ m.p.h., the comparative resistances are:

Streamlined car = 1,500 lb.
Flat Plate (160 sq. ft.) = 4,200 lb.

The difference, or 2,700 lb., would be available to assist in retarding the train by virtue of the provision of vanes which would take advantage of the potential force available in the air.

While it is not possible to anticipate the utilization of the entire clearance diagram for effective area to be presented to wind effects, there is nothing to limit the number of such collapsible vanes advantageously located along the train, operated pneumatically and automatically upon each emergency brake application, and receding into the car structure or folding back into recesses in the car sides, maintaining an unbroken surface contour when not in use. If retractable vanes were fitted to the front of the leading car of a streamlined, multiple-unit train, providing an equivalent flat plate area of 140 sq. ft. with a vane of 25 sq. ft. projected area fitted at the rear of each car, assuming that the vanes at the car ends offer a unit resistance equivalent to the head-end value, there will be offered the equivalent of 290 sq. ft. frontal area. This is probably too high a value to be used in view of the interference caused by successive interruptions of the air stream and a better value for estimate may be 250 sq. ft.

The resistance offered will be,

$$0.00324 \times 250 \ V^2 = 0.810 \ V^2$$

and the added resistance to motion of the train will be,

$$(0.810 - 0.185) \ V^2 = 0.625 \ V^2$$

The effect of this force at various speeds of traveling is given in the table.

Resistance Introduced by Wind Brakes

Speed m.p.h.	Added resistance afforded by wind brake, lb.
90	5,060
80	4,000
70	3,060
60	2,250
50	1,560
40	1,000
30	560

Since the kinetic energy possessed by a moving train varies with the square of its speed, as does the resistance due to the wind brake, such a brake is especially desirable to be used in conjunction with the conventional air brake. From speeds of 40 m.p.h. to stop, it is not difficult to obtain by the use of the conventional air brake alone all the retarding force which can be safely impressed. At the higher speeds, when the coefficient of friction is materially reduced in value, the wind brake affords a practical means for supplementing the dimin-

ished retarding effect. The exact benefit that can be expected from the use of a wind brake such as that described, in the way of decreased stopping distance, is not immediately predictable. Its effect is dependent largely upon the measure of increase of car cross section, upon the degree of streamlining practiced, the weight of the train, and the speed of operation.

Air Brakes Adequate for Present Needs

Whatever expedient has been yet tried or suggested to increase the available rate of retardation from high speed beyond that obtainable with pneumatic brakes, electrically operated for simultaneous response throughout a train of coupled cars, none is offered which assumes the importance of the highly developed air brake which must be relied upon to form the basic retarding medium under all circumstances. The time has not yet arrived when the capacity of the air brake places a definite limitation upon the maximum speed which may be practiced, even upon well constructed and maintained track, fitted with heavy rail sections and with curves of large radii, on which the outer rail is properly elevated. The maximum retardation rate of 3.5 m.p.h. per sec., obtainable by retarding the rotation of the wheels, is not yet utilized, due in part to imperfect rail surface, in part to inadequate control of weight transfer, and in part to the hesitancy of railway administrations to attempt radical innovations in practice, no matter how desirable it may be to accomplish the purpose for which they are designed. The increase to the maximum rate will be cautiously pursued and retardation rates will advance little by little as they have in the past, with associated improvements installed to insure protection against possible discomfort within the trains and damage to wheels. Effective and positive sanding of the rails at various points throughout the length of the train is required to insure the attainment of the minimum coefficient of wheel-rail adhesion of 0.16, irrespective of rail condition, since this value must be sustained if the maximum rate of retardation is to be obtained with security.

Effect of

Natural Winds on Air Drag

By George W. DeBell

Derivation of conversion formulae and presentation of curves of increase in the drag of passenger trains, operating at constant speed, caused by natural winds

In actual operation we are interested in the increase in air drag, at constant train speed, due to natural winds. The magnitude of this increase may be derived from wind-tunnel tests of the train at various angles of yaw, but the determination entails considerable mathematical computation. It is the purpose of this article to present the derivation of the conversion formulae and show curves of drag increase with natural winds, at constant train speed, for streamline power-car trains, streamline locomotive trains, and conventional steam trains.

The wind tunnel tests upon which these curves are based, were made in the New York University wind tunnel by the American Car and Foundry Company, the American Locomotive Company, and The J. G. Brill Company, cooperatively.* The tests included tests of trains of various lengths as well as of different contours. The models used in the yaw or quartering wind

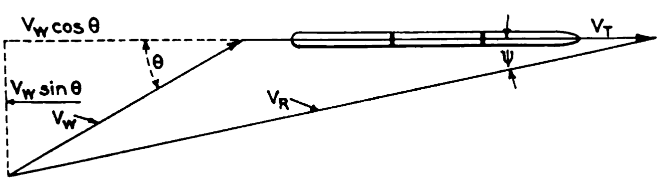


Fig. 1

tests were all made to a scale of 1-32 of full size and were in as complete detail as could be represented at this scale.

During the wind tunnel tests the air velocity was maintained constant and, therefore, the ratio of the drag at yaw angle to the drag at zero yaw, as obtained from these tests, is based on a constant resultant air speed and not on a constant train speed. Since we are really interested in the ratio at constant train speed we must compute new ratios based on the natural wind velocity and direction and the drag ratios from the wind-tunnel tests.

It will be noted that in deriving the formulae for computing this revised ratio we have assumed that the air drag varies as the square of the velocity. This may be done without appreciable error, as, in the yaw condition, most of the drag is pressure or vortex which is proportional to the square of the velocity. It may be well to mention here, that, in this article, the word "drag" refers to the air force component which is parallel to the track and, therefore, directly affects the train resistance:

Let

V_w = velocity of natural wind
V_t = velocity of train
V_r = velocity of resultant wind
θ = angle between natural wind and track
For head wind, $\theta = 0°$
For tail wind, $\theta = 180°$
$r = \dfrac{V_w}{V_t}$ ratio of natural wind velocity to train velocity
Ψ = angle of yaw = angle between resultant wind and track
R_r = ratio of drag at angle of yaw Ψ to drag at zero yaw, based on constant resultant wind speed.
(Obtained from wind tunnel tests)

* For a general description of these tests see the *Railway Mechanical Engineer* for December, 1935, page 496.

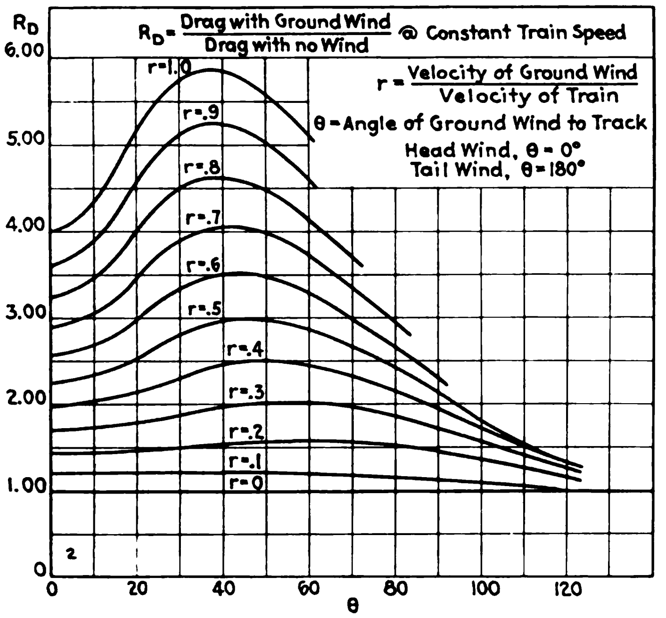


Fig. 2—Increase in drag, due to ground winds, at constant train speed—Power-car train with open skirts

R_d = ratio of drag with natural wind to drag with no wind (still air), based on constant train speed.

Then

$$V^2_r = V^2_w \sin^2\theta + (V_t + V_w \cos\theta)^2 = r^2V_t^2 \sin^2\theta + V^2_t(1 + r\cos\theta)^2$$
$$= V^2_t\,(r^2\sin^2\theta + 1 + 2r\cos\theta + r^2\cos^2\theta) = V^2_t\,(r^2 + 2r\cos\theta + 1)$$

Or

$$\frac{V^2_r}{V^2_t} = r^2 + 2r\cos\theta + 1$$

But

(Drag at angle Ψ and wind velocity V_r) =

(Drag at zero yaw and V_t) $\times R_r \times \dfrac{V^2_r}{V^2_t}$ = (Drag at zero yaw and V_t) $\times R_d$

Therefore

$$R_d = R_r \times \frac{V^2_r}{V^2_t} = R_r \times (r^2 + 2r\cos\theta + 1)$$

Also

$$\Psi = \tan^{-1}\frac{V_w \sin\theta}{V_t + V_w\cos\theta} = \tan^{-1}\frac{rV_t\sin\theta}{V_t + rV_t\cos\theta} = \tan^{-1}\frac{r\sin\theta}{1 + r\cos\theta}$$

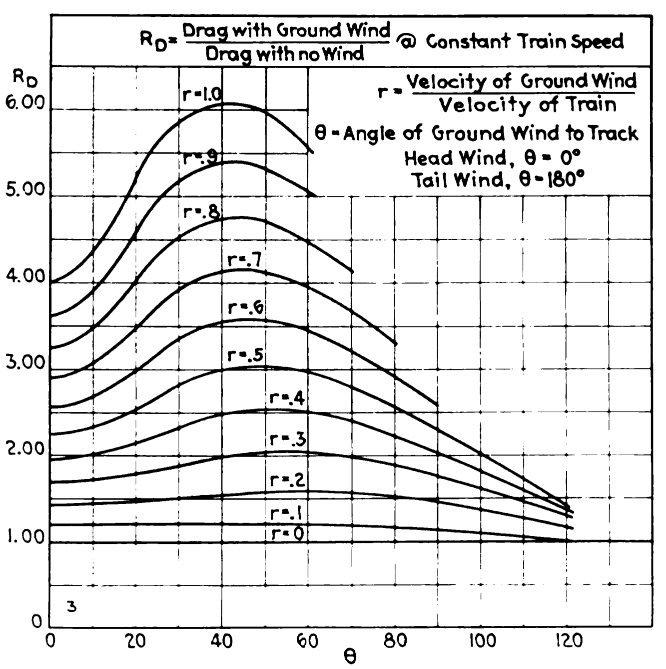


Fig. 3—Increase in drag, due to ground winds, at constant train speed—Power-car train with closed skirts

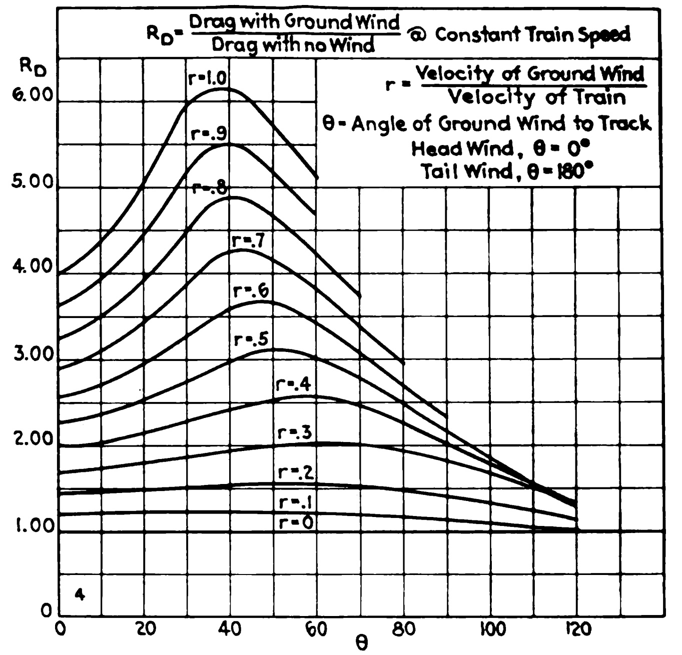


Fig. 4—Increase in drag, due to ground winds, at constant train speed—Streamline locomotive and trail car

The values of R_d have been computed for all the models which we tested in our wind-tunnel program and the results of these computations are plotted in Figs. 2, 3, 4 and 5.

Fig. 2 applies to the power-car trains with open skirts. Fig. 3 applies to the power-car trains with closed skirts. Fig. 4 to the streamline locomotive trains, and Fig. 5 to the standard New York Central trains.

It will be noticed that these figures do not show any variation with the length of train. This is substantially correct as the preliminary plots of the R_r ratio, which were made from the wind tunnel results for each length of train, showed the curves to be interlocking and therefore, the average curve was used in computing the above mentioned figures. This eliminated the effect of train length.

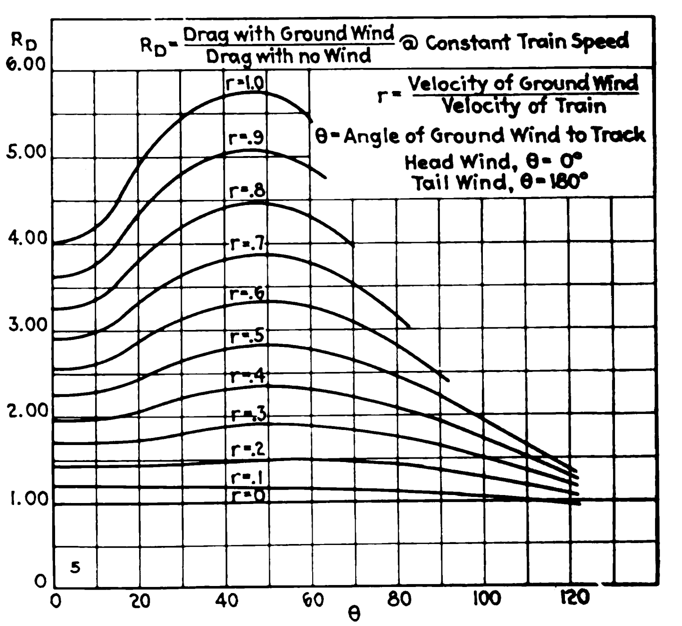


Fig. 5—Increase in drag, due to ground winds, at constant train speed—Conventional New York Central train

It is our belief that the use of the average curve does not affect the ratio by more than 10 per cent and this is negligible since in actual service the natural wind conditions are constantly varying.

In the above mentioned figures it will be noted that R_d has been plotted against the angle of natural wind, θ, with parameters of r, the ratio of natural wind velocity

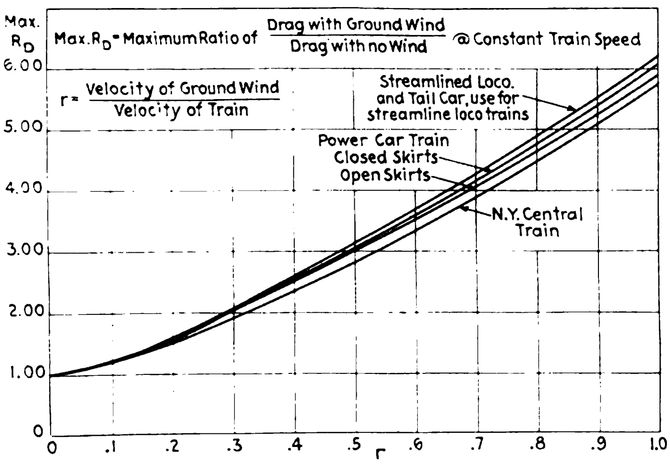


Fig. 6—Maximum increase in drag, due to various ground wind velocities, at constant train speed

to train velocity. It is interesting to note that the maximum value of R_d practically always occurs at a value of θ approximately 40 deg. to 50 deg, regardless of the type of train.

Since, in actual practice, the direction of the natural wind is seldom known, it is safest when applying these figures to use the highest value of R_d applying to the known velocity ratio, r. This has been done in Fig. 6 which shows the maximum value of R_d versus the ratio of the natural wind velocity to train velocity for the different types of trains. Where the angle of the natural wind is unknown or questionable it is therefore suggested that Fig. 6 be used.

Using the values of R_d as taken from the above mentioned figures the drag of a train under the influence of a natural wind may be computed by selecting the proper value of R_d and multiplying it by the drag of the train in still air.

Expressed in equation form:

Where:

D_w = the air drag of the train under the influence of a natural wind V_w.
D_o = the air drag of the train in still air at a train speed of V_t.
R_d = factor as obtained from charts.
$D_w = R_d \times o$.

In actual service some allowance for average wind conditions should be made if a higher value of on-time performance is to be maintained. This can readily be seen from Fig. 6 which shows that a natural wind of one-third of the train speed may more than double the air drag and that a natural wind of one-fifth of the train speed may increase the air drag by more than 50 per cent. In a majority of cases the exact magnitude and direction of the wind varies and, therefore, we must resort to averages in order to make wind allowances. At the present time, for want of more accurate information, we suggest that the year round average wind velocity for the particular locality of the run be used, and that the wind be assumed always to come from the worst direction. Then having determined the average wind velocity, we can find the drag increase ratio by referring to Fig. 6.

After we have had more experience in the operation of streamlined trains, we will undoubtedly be able to arrive at a closer approximation of the actual average wind, but at the present time in order to make some allowance for the effect of natural winds we must rely upon information obtained from the Government Weather Bureau, from whom we can get the year round average winds. Later we may find that we should apply a correction factor to these average winds in order to obtain a more accurate working value for performance estimation, but, as we have previously mentioned, the derivation of this factor will depend upon the data obtained from actual operation of streamlined equipment.

In conclusion, an inspection of Fig. 6 will show that streamlined equipment has a greater percentage increase in air drag with natural winds than does standard equipment. This is natural since as the angle of the resultant wind to the centerline of the train becomes greater the value of the streamlining becomes less pronounced until when the resultant wind hits the train at an angle of 90 deg. the value of the streamlining is small. However, due to the much lower resistance of the streamlined equipment at zero yaw, the air drag of the streamlined equipment, even with the most adverse natural wind, is still much less than that of the equivalent conventional equipment.

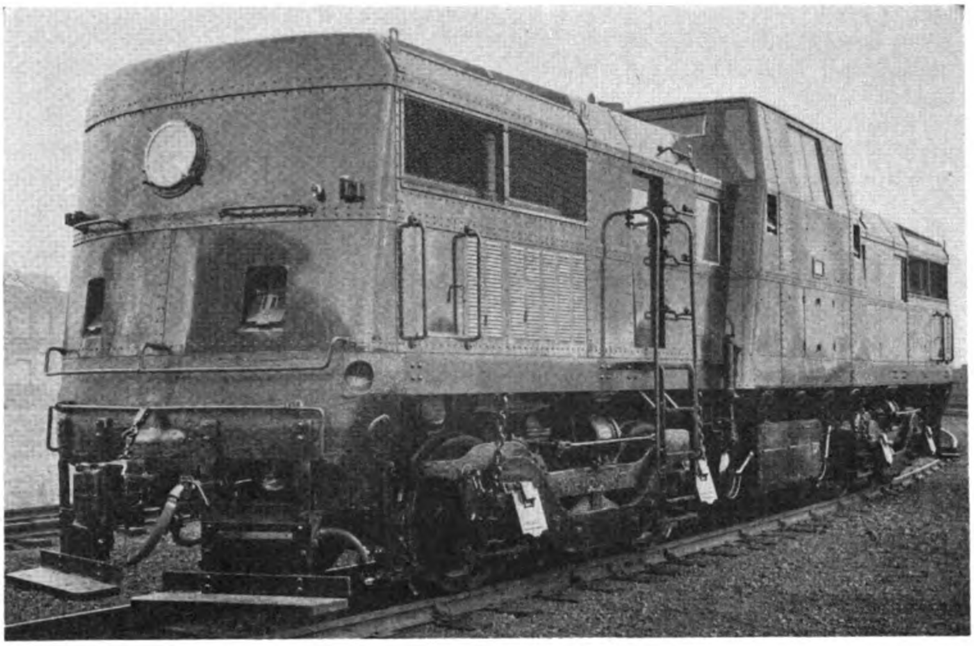
Diesel-Electric Freight Locomotive

A 1,600-hp. 133-ton Diesel-electric locomotive has been completed by the Westinghouse Electric & Manufacturing Company. The specifications drawn up before the locomotive was built required that the total weight be carried on four driving axles, that the mechanical features be sufficiently simple and durable to meet the most severe freight-service requirements, that all ordinary maintenance of power plant and auxiliary apparatus could be carried out without dismantling the cab structure, and that the unit be suitable for one-man operation.

The locomotive consists of a visibility-type cab and two equipment hoods mounted on an integral cast-steel underframe, carried on two four-wheel, swivel-type trucks. The centrally located operator's cab has its floor and roof raised above the levels of the main floor and hood roofs, respectively, and is built to a width exceeding that of the equipment hoods and supporting underframe, which, with suitably arranged windows, provides for visibility both over and along the sides of the equipment hoods. The operator's cab and equipment hoods are streamlined to a degree sufficient to avoid the box car appearance frequently found in units of this type. A Diesel power plant with its auxiliary equipment is housed in each of the equipment hoods.

The underframe incorporates storage reservoirs for fuel and lubricating oil, mounting rails for the engines and generators, air ducts for traction-motor ventilation, truck center plates, cab side bearings and bolsters, draft-gear housings, four sand boxes and push-pole pockets.

The trucks have integral cast-steel frames, side equalization with semi-elliptic springs, clasp brakes, carbon-steel axles, A.A.R. boxes and brasses with 8-in. by 14-in. journals and rolled-steel wheels. All wearing surfaces on the truck frame and underframe are protected with hardened-steel plates and holes for brake-hanger pins are bushed. Truck and underframe center plates are likewise bushed with hardened-steel bushings.



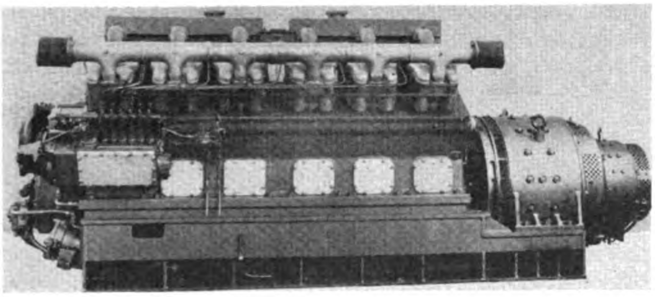
The Westinghouse 1,600-hp. Diesel - electric locomotive for freight service

Driving journals are oil lubricated and hub liners and center plates are arranged for Alemite lubrication. Pedestal ways are oil lubricated from oil-and-waste pockets on the box.

The unit is equipped with A.A.R. type 6-in. by 8-in. shank swivel-butt couplers and Miner friction draft gear, Peacock type hand brake, Graham-White sanders, Pyle-National headlights and number boxes, and air-operated window wipers and bell.

Diesel Engines

The Diesel engines are rated 800 hp. each at 900 r.p.m. They are of the solid-injection, 12-cylinder, V-type, op-



One of the 12-cylinder, V-type, 800-hp. Diesel engines

erating on the four-stroke cycle. They have integral cast-steel crankcases which are machined for cylinder liners and heads, main bearings, cam-shaft bearings, gear case and fuel pump mountings and inspection cover plates. All engine auxiliaries, such as main fuel pump, water pumps, lubricating-oil pressure and scavenging pumps, governor oil pump and cam shafts, are driven by gears at the front end of the crank case.

Removable liners of nickel cast iron are fitted in the crank case. Each cylinder is provided with an individual cylinder head, cast from aluminum alloy with steel valve seats for dual inlet and exhaust valves. The pistons are made from an aluminum alloy and machined for pressure and oil-control rings.

The fuel injection system consists essentially of a motor-driven gear pump, taking fuel oil from the main reservoir and delivering it through strainers to the main fuel-pump headers, at a pressure of approximately 30 lb. per sq. in. A main fuel-pump assembly, consisting of six units, is mounted on each side of the crank case serving the six adjacent cylinders.

Electrical Transmission

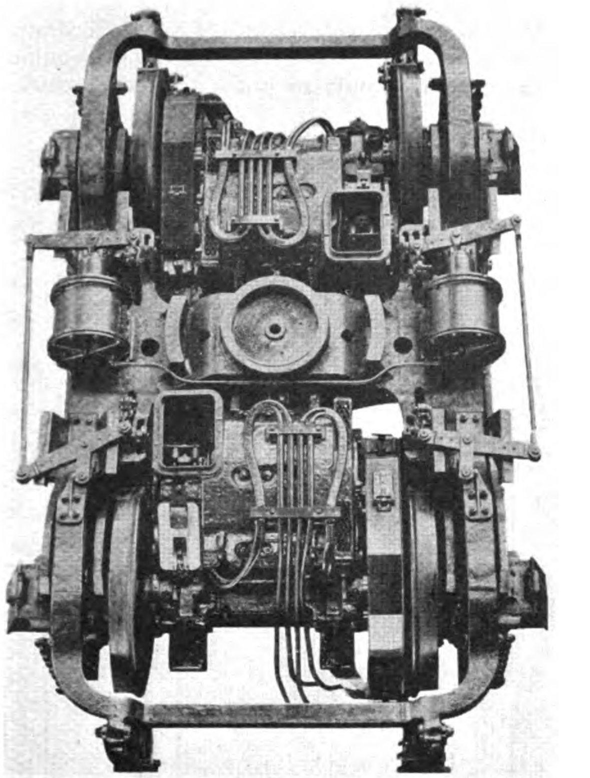
Each power plant has a single-bearing main generator which converts the mechanical power at the engine shaft to electrical energy for use by the traction motors.

An auxiliary generator is mounted on each of the main-generator bearing brackets, with its armature on an extension of the main generator shaft. A fan, mounted on each engine flywheel, draws air through the main and auxiliary generators, cooling both machines. The main generators are used as motors for cranking the Diesel engines during starting.

Four traction motors, utilizing the electrical power furnished by the main generators supply the propelling force for the locomotive. One motor is geared to each of the driving axles through a pinion on the motor shaft and a gear on the driving axle. The gearing is a spur type, machined from steel forgings and heat treated. The traction motors are of the direct-current series type, force ventilated and equipped with roller-type armature bearings and split-sleeve type axle bearings.

Control and Brake Equipment

The locomotive is equipped with Westinghouse standard dual control, developed especially for Diesel-electric locomotives to provide maximum flexibility with one-man operation. Pedestal-type controllers and brake-valve operators are located at each of the operating stations. Their shafts extend through the cab floor, and are inter-connected with sprocket gears and chains. A standard K14 brake valve, minus the handles, is located directly below one of the brake-valve operating pedestals with their corresponding shafts connected together. Westinghouse modified schedule 14-EL air-brake equipment with quick application and release feature is used. Two single-stage, two-cylinder, water-cooled air compressors, each having 120 cu. ft. displacement, driven by a 115-volt, direct-current, series motor, furnishes air for the operation at the brakes and electro-pneumatic control equipment. Both compressors and motors are equipped with ball bearings.



A view of the truck showing the arrangement of the motors and brake equipment

Two 14-in. by 10-in. brake cylinders are mounted on each truck, one cylinder being connected to the brake rigging on each side of the truck. An auxiliary hand brake is connected to one truck for holding the light locomotive at standstill.

Engine loading is controlled over the range of generator voltage and current by the Westinghouse torque-control system. Meter and gage panels, located at each operator's station, include meters for indicating main generator amperes, battery amperes, engine jacket water and oil temperatures, and air-brake gages.

The initial starting of each engine is controlled from positions adjacent to the respective engines. Starting and stopping of each engine may be controlled from the operator's station by electro-pneumatic mechanisms after main-reservoir air pressure has been pumped up. The starting battery consists of a 50-cell, Exide Ironclad battery having 15 plates per cell.

The control is arranged for the operation of all traction motors from either power plant, with the second power plant non-operative.

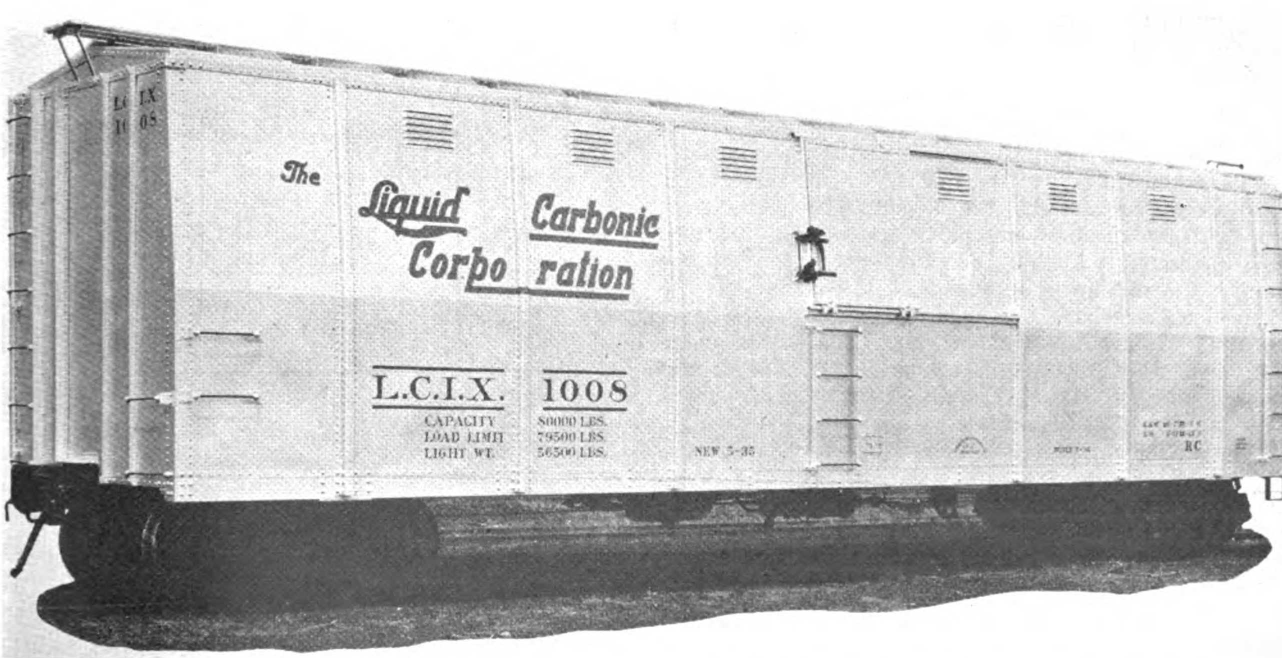
Foot-operated push buttons are located, one at each operator's station, for controlling weight-transfer compensating switches to permit working all drivers at maximum adhesion when the greatest starting tractive effort is required.

General Characteristics

Starting tractive force at 30 per cent adhesion	80,000 lb.
Tractive force at continuous rating of traction motors	32,000 lb.
Speed at continuous rating of traction motors	15.6 m.p.h.
Maximum operating speed	50 m.p.h.
Minimum radius of curvature:	
Locomotive alone	85 ft.
Locomotive with load	175 ft.
Length inside coupler knuckles	52 ft. 11 in.
Length over operator's cab and hoods	49 ft. 8 in.
Overall width	10 ft. 2 in.
Heights from Rail:	
Overall (at operator's cab)	14 ft. 1 in.
Over hoods (at coupler ends)	11 ft. 8 in.
Truck center distance	27 ft. 0 in.
Truck wheel base	8 ft. 6 in.
Wheel diameter	44 in.
Capacity of fuel oil reservoir	1,000 gal.
Capacity of sand boxes	5,000 gal.
Capacity of jacket water system per engine	210 gal.
Capacity of lubricating oil reservoirs per engine	85 gal.

Who Names Cars?—Much has been written in lighter vein regarding the naming of Pullman cars. However, this department's entry for the most peculiarly-named car is the Canadian National parlor car operating between Montreal and Portland, which rejoices in the name Batchewaung.

* * *



Special insulated car—A. A. R. Class RC—built by the American Car and Foundry Company for transporting 30 tons of dry ice in 55-lb. cakes. Lower half of car consists of a series of heavily insulated bins

Stack Arrangement on N. P. 4-8-4 Type Locomotives

A novel and interesting design of smokestack was employed on the latest 4-8-4 type passenger locomotives built for the Northern Pacific by the Baldwin Locomotive Works, a general description of which was given in the *Railway Mechanical Engineer,* December, 1934. These large locomotives, known as Class A2 and numbered 2,650 to 2,659, inclusive, weigh 489,400 lb., have a rated tractive force of 69,800 lb., 28-in by 31-in., cylinders, carry 260 lb. boiler pressure, have 4,964 sq. ft. of evaporative heating surface and a grate area of 115 sq. ft.—fuel being Rosebud lignite coal.

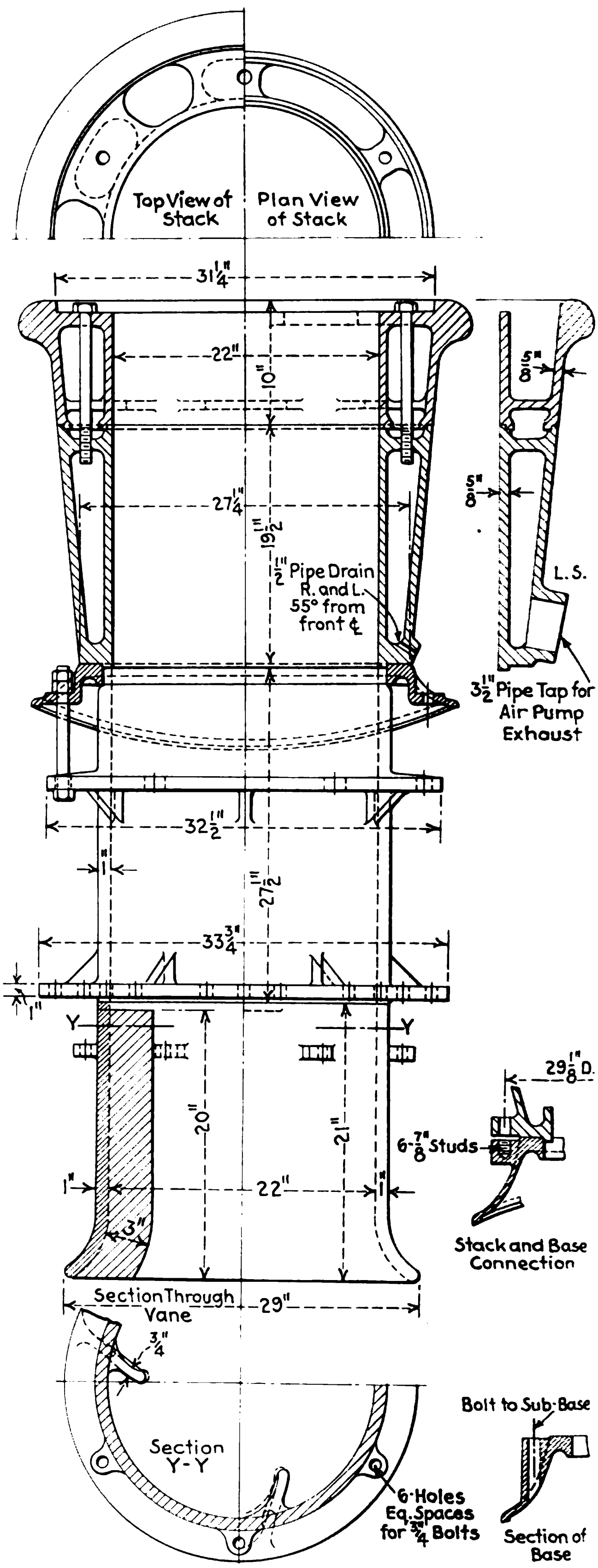
The smokestack arrangement was worked out by the railroad to meet the conditions obtaining on its line. The stack has the unusual height of 17 ft. 2 in., above the rail. The center line of the boiler is 10 ft. 8 in. above the rail; the diameter of the smokebox is 88 in.; the stack is set 76 in. ahead of the front tube sheet and $66\frac{1}{16}$ in. back of the smokebox front-end casting. The main purpose of this unusually high stack is to prevent as much as possible the trailing of smoke and steam around the dome and cab which would interfere with the view of the enginemen, when the locomotive is operated with a light throttle or is drifting down grade. It is reported that the arrangement has proved highly effective in overcoming this trouble.

The top portion of the stack is a removable extension casting, 10 in. in height, which is held on by six $\frac{7}{8}$-in. tap bolts equally spaced on a $26\frac{1}{2}$-in. diameter circle. This top can thus be easily taken off when the locomotive is to be operated in a territory where tunnels or clearance restrictions require a reduction in stack height to 16 ft. 4 in.

The stack, which is of the straight type with an internal diameter of 22 in. and a total height of 6 ft. $6\frac{1}{4}$ in., is made up of five castings—top, stack proper, base, sub-base and extension. The base is a steel casting; the other portions are cast iron. The bottom extension terminates in a small bell, $\frac{1}{4}$ in. below the center line of the smokebox and approximately 13 in. above the top of the exhaust nozzle. This portion of the stack has three chilled veins 3 in. high.

The stack is attached to the base by six $\frac{7}{8}$-in. studs on a $29\frac{1}{8}$-in. diameter circle and the base to the smokebox by six $\frac{7}{8}$-in. bolts on a $32\frac{1}{8}$-in. diameter circle. After the base has been bolted in place it is welded all the way around to add to the security of the attachment and to assure an airtight joint. Six $\frac{7}{8}$-in. bolts on a 30-in. diameter circle attach the subbase to the base and six $\frac{3}{4}$-in. bolts on a 26-in. diameter circle serve as attachment for the lower extension. The flange on the bottom of the sub-base is a wide one and, in addition to supporting the lower extension, has 16 holes for $\frac{3}{4}$-in. bolts on a 31-$\frac{3}{4}$-in. diameter circle for holding the Cyclone front-end Type A spark arrester with which these locomotives are equipped.

An unusual feature in the design of this stack is the provision of an annular space between inner and outer walls into which the exhaust from certain of the steam-operated auxiliaries is piped. This arrangement provides a much neater appearance than obtains when independent exhaust pipes are led up alongside of the stack. On the left hand side there is a boss tapped for $3\frac{1}{2}$-in. pipe for the exhaust from the two $8\frac{1}{2}$-in. cross-compound air-compressors, and on the right hand side there is a boss which is tapped for a 2-in. pipe on the locomotives equipped with Worthington feedwater heaters or for a 3-in. pipe on the locomotives equipped with Wilson water conditioners. Two $\frac{1}{2}$-in. drain pipes are also provided to carry off any condensation that would otherwise accumulate in the annular exhaust space.



Smokestack of Northern Pacific 4-8-4 type locomotive

EDITORIALS

Some Notes On Boiler Welding

One of the most comprehensive recent discussions of railway shop welding practice was that presented before the January 9 meeting of the Pacific Railway Club by Frank A. Longo, welding supervisor, Southern Pacific general shops, Los Angeles, Cal. Boiler welding constitutes an important part of all railway shop welding operations, and, touching this subject, Mr. Longo called attention to the excellent results being secured by the electric arc process, using heavy coated welding rod and securing welds with better physical characteristics than the original plate, as regards tensile strength, ductility and ability to withstand repeated stresses. As a result of this improved practice, firebox construction and maintenance cost have been greatly reduced.

Firebox life has also been substantially increased, an accomplishment which must be credited both to the more extensive use of treated boiler water and improved welding practices. It is reported that, on the Southern Pacific, for example, in the twelve-year period from 1913 to 1924, a total of 2,127 fireboxes were applied on the Pacific System, this number being reduced to 977 fireboxes in the eleven-year period from 1925 to 1935. At Los Angeles shops alone during the year 1920, a total of 104 fireboxes were applied. By 1925, the firebox applications had dropped to 36; and in 1935, only one firebox was applied.

An interesting suggestion is advanced regarding the welding methods used in fabricating new fireboxes. In Southern Pacific practice, the single V-type butt weld is used; and as the welders have access to both sides of the sheets, the seams are welded from both sides. After the box has been completely welded from the fire side, a diamond point chisel is used to cut a V-shaped groove in the back of the weld of sufficient depth to remove all flaws. This groove is then welded and a weld of maximum strength is secured. The caulked edges of the door sheet, flue sheet and four mud-ring corners are sealed with electric welding.

The Southern Pacific practice in applying firebox patches by welding, as described by Mr. Longo, consists of cleaning and beveling the edges of both the old and the new sheets to a 30-deg. angle, or a 60-deg. opening for both. The new sheet is bolted in place and spaced to leave a gap of 1/16 in., the seam then being tack-welded about every 15 in. to hold the patch in line, after which the straps are removed. The first, or pressure, bead is made with 1/8-in. welding wire to assure penetration, as the weld in the water side must be clean and flush with the sheets and with no gaps or mud catchers. The first bead is laid directly in the center of the seam, no attempt being made to fill the gap. After the first bead is applied, 5/32-in. and 3/16-in. electrodes are used, each layer of weld metal being thoroughly cleaned of all scale. Patches are applied to any part of the firebox.

In applying patches to the front flue sheet, enough flues are removed to enable the welder to reinforce the weld from the water side. If the back flue sheet is renewed, a 3/4-in. front flue sheet is applied instead of patches, the front flue sheet being cut horizontally above the top row of flues to avoid the necessity of removing the unit header. This patched section is well braced and not subject to deterioration and cracking. Half-inch gusset plates are welded to the knuckle of the front flue sheet in the smokebox side. The life of cracked front flue sheets has been extended by welding the crack and applying these gussets, one flue sheet thus repaired having been in service for ten years and two others for eight years, each.

One of the first applications of welding on the Southern Pacific was in the welding of superheater flues to the back flue sheet. Mr. Longo's description of how this work is now done is very concise and to the point: "The holes in the back flue sheet are countersunk at a 45-deg. angle half-way through the sheet. Each flue is cut so that it will lack about 1/16 in. of coming through the sheet in the firebox. The flue is then given a light rolling to set it to the sheet, then being prossered as close to the sheet as possible. The flue is belled out or laid over in the countersink, after which the flue is welded with a good substantial bead, fusing well into the end of the flue to make a strong welded joint. There is no projection of the weld on the firebox side, as this weld is flush with the sheet and will run the life of the flues without trouble. Small flues are not welded until the life is about gone from beads. Then they are expanded, beaded, cleaned and sandblasted for welding. A small bead is welded around the original bead and the flue life extended about 14 months. In combustion chamber fireboxes it is much longer."

The detailed practices of the Southern Pacific in boiler welding are interesting and may suggest comments from readers of *Railway Mechanical Engineer,* particularly with regard to the necessity and desirability of cutting the V-shape groove in firebox butt welds, this groove then being welded with a view to securing a final composite weld of maximum uniformity and strength. A railroad locomotive shop was formerly rated more or less on the number of fireboxes it could apply, but now the emphasis is on how many fireboxes can be saved. The Southern Pacific record in this particular is impressive, but doubtless can be equalled or exceeded on some other roads. *Railway Mechanical*

Engineer would be glad to receive and publish for the benefit of its readers information regarding the maximum firebox life which is being secured by modern welding practices in boiler construction and maintenance.

New Equipment Orders in 1936

One of the most encouraging evidences of the continued progress, indeed acceleration, of recovery, is the volume of equipment orders which have been placed by the railways in the United States during the first quarter of 1936. The orders for steam locomotives during this period have completely eclipsed the orders placed throughout 1935, and those for internal combustion type locomotives, including those for new streamline trains, amount to considerably more than a quarter of the number placed last year.

During the first quarter of 1936 orders have been placed for 62 steam locomotives and 14 internal combustion locomotives, including those which will form the motive power for streamline trains now under construction. During the entire year 1935 a total of 83 locomotives of all types were ordered, of which 48 were internal combustion, 7 electrics and but 28 steam. Orders were placed for 8,913 freight cars as compared with the orders for 18,699 placed for use in the United States during the entire year 1935. In the case of passenger cars, the 37 passenger coaches and the 32 body units in the four articulated, or semi-articulated, streamline trains ordered so far this year compare with 63 passenger cars and 40 body units in the articulated trains or single rail-motor cars ordered during 1935.

Two forces are principally involved in determining the time and amount of railway equipment purchases. The first is the ability of the railways to finance the purchases, and the second is the immediacy of the need for the equipment, or, stated negatively, the degree of success with which the railways can continue to handle all business available with the existing supply of motive power and rolling stock. The second force directly affects the first, but under certain conditions may be something of a determining factor in spite of the first.

The net railway operating income of the Class I railways showed a definite improvement during the latter part of 1935 as compared with the same period of 1934, and this improvement is continuing during the present year. From September to January, inclusive, the increase has aggregated approximately one third and preliminary figures for February indicate an even better comparison with February of 1935.

During this same period increasing demands have been made on the available supply of motive power and rolling stock. The number of locomotives stored serviceable never declined below 4,000 during the peak years of 1928 and 1929. Since September 1 the number has not been above 4,000 and it had declined to 2,419 on February 1. Throughout the depression the number of locomotives on line has steadily declined and stood at 45,391 as of February 1, while the number unserviceable still holds close to 11,000 in spite of the upturn in maintenance which followed closely the increase in locomotive-miles in the last quarter last year.

Much the same trend has prevailed with respect to freight cars. The total number on line has declined steadily since 1931, while the number in shops has remained well toward 300,000 during the past three years and has not yet showed signs of an appreciable decline. Surpluses, however, have been declining since 1933 and, on the basis of the present surplus of less than 300,000, may be expected to drop close to the 100,000 margin of safety during the period of peak traffic this fall.

There is, therefore, ample reason for the increase in equipment buying which has been so marked during the past three months. Improved net railway operating income, which is the index of railway purchases, and the rapidly narrowing margin of surplus motive power and freight rolling stock are ample explanation for the increase and suggest that it is likely to continue. Whatever passenger rate reduction goes into effect in the east, it is almost sure to create an early shortage of passenger rolling stock which will have to be met by purchases of new equipment.

Railroads Make Excellent Record in Smoke Prevention

"Railroad smoke has been reduced 95 per cent, the records show. The average locomotive smoke density for 1935 was 1.727 per cent, compared to 16.03 per cent in 1931. These figures are obtained from the average of more than 10,000 Ringelmann chart readings made each year." This statement appears in the annual report of the smoke abatement engineer of Hudson County, N. J.

In February of this year 880 observations of locomotive performance were made on the nine railroads operating in that county, showing an average smoke density of 1.65. The New York, Ontario & Western led the list with a percentage of 0.00, while the Delaware, Lackawanna & Western came up in the rear with a density of 3.20, the Baltimore & Ohio being a close runner-up for the end place with a percentage of 3.00. The New York Central and the Erie fought for the second place at the top of the list, with percentages of 0.40 and 0.42, respectively. Between the extremes, graded in the order of good performance, came the Pennsylvania, Lehigh Valley, Central Railroad of New Jersey, and Reading.

These results were not obtained by the making of rules and regulations, but rather on the basis of

recommending good practices. These recommended practices, however, were not handed down as a fiat on the part of a governmental authority, but are the result of co-operative endeavor on the part of the railroads, through the organization of a Railroad Smoke Association. This organization holds monthly meetings to consider various phases of the smoke problem as it relates to the railroads. Smoke is an evidence of poor combustion and waste of fuel. The railroads profit from smoke prevention through reduced costs of operation and the community gains in cleanliness and more healthful conditions.

The railroads are not the only ones that have made a good record in Hudson County. The industrial plants are reported to have made a decrease of 93 per cent in violations in the past five years, while the steamships, tugs and ferries show an improvement of 94 per cent in reduction of violations of the smoke ordinance.

While a number of cities have smoke abatement departments, the movement seems to be gaining in impetus. That it has tremendous possibilities is indicated by a statement in the official bulletin of the Smoke Prevention Association, Inc., which is credited to Frank A. Chambers, deputy inspector in charge of the smoke abatement department of Chicago. It shows that an average of 67 tons of dust per square mile fell on Chicago last year, as compared with 95 tons in 1934, and 390 tons in 1930. The decrease in 1935 as compared to 1934, was 29 per cent.

Rough Riding Cars— What Does the Passenger Think?

During the past three or four years in which the railroads have made rapid strides in the development of equipment designed to contribute to the greater comfort of the traveling public many roads have spent considerable sums on new types of cars. New car structures have been developed with the idea of reducing the weight of cars thereby cutting down the cost of handling trains without resorting to increases in the hauling capacity of motive power. Interiors have undergone radical changes. Pleasing color schemes, more comfortable seats, air-conditioning, better lighting and improved interior arrangement have resulted in modern coaches which are far more attractive, in many instances, than the chair and club cars of a few years ago. Reduced fares have brought new customers to the railroads and, with improved schedules at higher speeds, there is every indication that the roads may look forward to a continued improvement in passenger business.

It might be well, just at this time, to call the attention of passenger equipment designers to the fact that the train-riding public is not universally enthusiastic about all of the new types of cars. When a traveler selects the railroad for a journey in preference to a bus or his own automobile he does it in many cases because he believes that he can enjoy greater comfort and safety. Judging from casual remarks that have been heard from time to time many passengers have a real cause for complaint about the poor riding qualities of some of the new equipment. It is difficult to read a book or a paper in a car that vibrates or has a tendency to side-sway to an extent that the type on a page is continually jumping before one's eyes and, at high speed, violent action of a car body gives the nervous passenger a feeling that something might happen. The fact that anything rarely does happen is of small comfort to that type of person.

Some of the new equipment that has been placed in service in the past four years is performing in a manner that is winning new friends for the railroads on every trip but, unfortunately, there are other instances where there is still much to be done to provide the traveler with the comfort he has the right to expect. Possibly it would be a good idea for the roads to make an intensive effort to find out, by contact with passengers, what they think of the riding qualities of modern passenger cars. It would at least provide much food for thought on the part of the designers of our cars.

NEW BOOKS

SPEED, SPACE AND TIME. *By Vernon Sommerfield. 299 pages, 7⅞ in. by 5¼ in. Illustrated. Bound in cloth. Published by Thomas Nelson & Sons, Ltd., London, Eng. Price, $2.50.*

Here is a brief and fascinating story of "man's attack upon space and time through the development of transport by land, sea and air." By the author's dramatic assertions that "the Romans were able to travel as fast as their eighteenth-century descendants" one is brought to a new realization of how the world of transport has moved in the past century. While the book is concerned in the main with achievements of the past 50 years, it does take time for brief speculation on transport in prehistoric times before proceeding to consider in turn the ship, the highway, the railway and air transport. In his discussion of railways the author claims, among other novel revelations, that interchangeable containers for freight transport were suggested as early as 1830, and that experiments in air-conditioning of passenger cars, "so often regarded as of foreign origin," were made "so long ago as 1906 on the lines forming the East Coast Route to Scotland." Also, he finds it significant that "in the two countries in which the railway system has reached its highest stage of development—Great Britain and the United States—state ownership does not exist." A final section looks into the future, speculating on such things as the cost of speed, the prospects for railway electrification, the problem of the highways, rocket planes, and remote control of vehicles.

THE READER'S PAGE

Car Foreman Takes a Shot at "Jim Evans"

To the Editor:

I have read the stories by Walt Wyre of the terrible tribulations of an imaginary roundhouse foreman, and really they make me laugh. Of course we all know that these are stories and are somewhat overdrawn, but I do believe that some roundhouse foremen and no doubt some car foremen imagine that their lives are just like that, when as a matter of fact such cases and such days are more or less the exception, rather than the rule.

If one were to take the stories literally he would believe that the life of the roundhouse foreman was such a terrible grind that it is hardly worth living, when as a matter of fact they just can't take it. In any well organized roundhouse the life of the foreman is no different from the lives of many other railroad men, the difference being the rest of us don't wolf about it, but realize that it is all a part of the job which we hold and in which we take a great deal of pride instead of holding ourselves up as martyrs of industry. We are proud to be a part of a smooth working organization, realizing that we have good jobs paying above the average for similar positions in other industries and we learn to take the bitter with the sweet, and like it!

Every man in a supervisory position on a railroad can pick one particular day and write a story a mile long about it, which, if taken as an average or everyday performance, would make it appear that he was just in the middle of a terrible fix and bring down heaps of sympathy on his poor head. I expect if his real name were made public he would soon find himself getting more fan mail than Major Bowes. However, taking the job as a year round proposition, he has a pretty darn good job even if he doesn't know it himself.

We in the car department don't come down every morning to lie in a bed of roses, but we do come down prepared to do the job at hand with a full realization that any minute ticked off by our watch may bring an emergency to take us off our regular spread and routine. Maybe it is a wreck, or one or a dozen hot cars switched to the rip for a manifest train which is called for an hour or two later, and every one of those cars must be fixed and switched back into the train without any delay. What do we do about it—tear our hair and blow up and write a story about it? No, we simply break up our present spread, take enough men out to fix the loads and everything goes along in a smooth and orderly manner; we fix the loads, get them out, and think no more of it.

We also have our material shortage problems and take orderly and proper steps to correct such conditions. When we do get up against it we don't hunt someone's shoulder on which to weep, but take steps to cover the situation either by making the material needed or by robbing another car, or what have you.

There is in my estimation no job of any kind on any railroad where a smooth running, orderly organization cannot be perfected and click as it should without any supervisor being in the same position as a man in jail, or a martyr to his great cause; nor should any well managed job be so confining that the foreman can't find any time whatever for relaxation of some kind without having to lay off to do so.

In short, it's just the old, old story. The roundhouse foreman or master mechanic all think because they are the birds who work on the engine that they are the whole railroad and that just because they put the engine on the head end of the train it is the money-maker, or the whole train, when as a matter of fact the engine is just a necessary nuisance and a money-spender rather than a money-maker. The cars that follow it are the boys that bring in the long green, and the "Dusty Buts" are the birds that keep them going.

Anyway I'll be happy for Jim Evans' sake when summer comes, because then he can have all daylight with which to play with his little engines and he won't have any frozen branch pipes; he may also have time to see his kids in daylight and find what a pretty world he really is living in.

A Car Foreman

Larger Fireless Locomotives

To The Editor:

We were interested in the Rail Oddity by Marinac in the *Railway Mechanical Engineer* of February, 1936, page 84, depicting the fireless locomotive which is used at the Brooklyn Navy Yard. In the description of this unit, however, we note a gross error. It states that the Navy Yard engine is the largest fireless switching locomotive ever built. There are 12 fireless steam locomotives operating in this country which are very considerably larger than the Navy Yard engine, including a 65-ton, six-driver, fireless locomotive which we built last year for the Ford Motor Company at Dearborn, Mich.

Harvey LeFevre,
Manager of Sales,
Heisler Locomotive Works.

[A folder which came with the letter indicates that these locomotives are built in all sizes from 5 to 90 tons.—Editor.]

First All-Welded Car

To the Editor:

Will you kindly tell me when, where and by whom the first successful, all-welded railway car of any type was built in this country.

H. O. Havemeyer, Jr.

The Baltimore & Ohio exhibited an all-welded, 95-ton capacity hopper car at the Mechanical Division convention in Atlantic City in June, 1930. Have any of our readers records of all-welded steel cars built prior to that time?—Editor.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Advertise Railroad Service

The automobile manufacturer does not hesitate to spend thousands annually to advertise his product in beautiful colors, and the railroads could and should do likewise.

Speaking of Shop Accidents

I went into one big shop noted for its fine safety record, but found men using crutches, fingers bandaged up, one with an eye blinker on, and learned that if it was at all possible they were kept at work so long as they could do anything at all. I wonder if this is how some of these fine records are made. With us a man does not start to work until he is practically able to resume his old job in an efficient manner.

Air Brakes and Faster Schedules

The Air Brake Association is one organization that has been very beneficial to the railroads as a whole. This association has not held a meeting for some time and I feel that with the improvement in operation of the railroads—that is, faster schedules and lighter trains—this association will again become a prominent factor in the formulation of rules and regulations to be applied in the handling of faster schedules, both freight and passenger.

A Large Vision

Give us editorials inspiring us to the responsibilities of leadership on our jobs and in our communities, inspiring us to face courageously the problems that confront railroaders in the changing world of economics, finance and scientific discovery we are passing through, reminding us that no country ever found its place as a great nation and shaped its destiny until it had men to face and overcome the greatest of difficulties in building its railroads; and no country can continue to hold its place without efficient, well managed railroads. Help us to follow worthily in the steps of the great captains whose names adorn the pages of our railroad history.

The Kid Glove Foreman

Some of the situations encountered by the "Kid Glove Foreman" (January, 1936, page 34) are humorous when seen from one angle, but tragic when considered from the angle of good supervision. It seems to me he should have learned the lesson of "being a new man on the job" and have refrained from hasty decisions and jumping at conclusions until he had become thoroughly familiar with the layout of the new plant and also knew something about the ability of the individual workmen. The general foreman or the master mechanic should have been interested enough in the new foreman's welfare to have accompanied him about the premises more than a half hour or so the first morning, just by way of seeing that he got an even break or better.

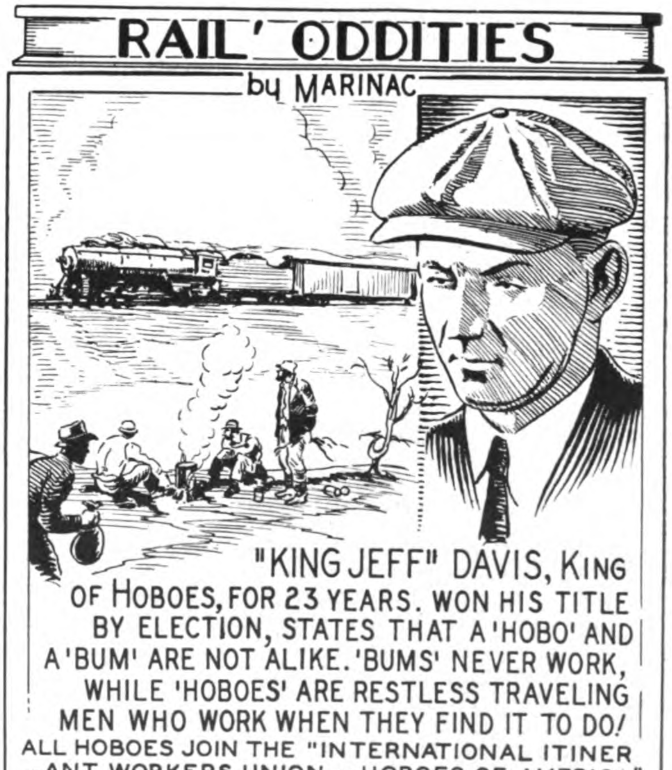
Roundhouse Facilities

I must say that in my opinion these roads were at least 30 years behind time in their roundhouses. They were not equipped with electric drop pits and I noticed that they were washing boilers and packing boxes in the yard, where they did not have any kind of pit. This was more noticeable to me, due to the fact that we have a modern roundhouse, each stall being equipped with chain falls on both sides. We also have four electric drop pits, a monorail running the entire length of the house, two 10-ton Whiting hoists, and many other modern conveniences.

Wood Burning Locomotives

Many changes have taken place since I first started. It may interest you to know that I completed my first general arrangement drawing at the Richmond Locomotive Works, where I was first employed, on November 3, 1889, and the locomotive in question was a wood burning engine for the Raleigh & Gaston Railroad. The engine had 17-in. by 24-in. cylinders and about 25,000 lb. per axle. Prior to that time they built what they called "pole" road locomotives and they were used for logging purposes. The wheels were made to fit over a round pine pole. The track was made by laying pine poles lengthwise—mostly in the mud. Probably they were tied across at some places, but the wheels were really double flanged and were kept on the road in this way. They seemed to have had quite a business along this line at one time, it having been inherited from the Tanner & Dulaney Engine Company.—*John A. Pilcher, mechanical engineer, Norfolk & Western Railway.*

* * *



For explanation see page 178

With the Car Foremen and Inspectors

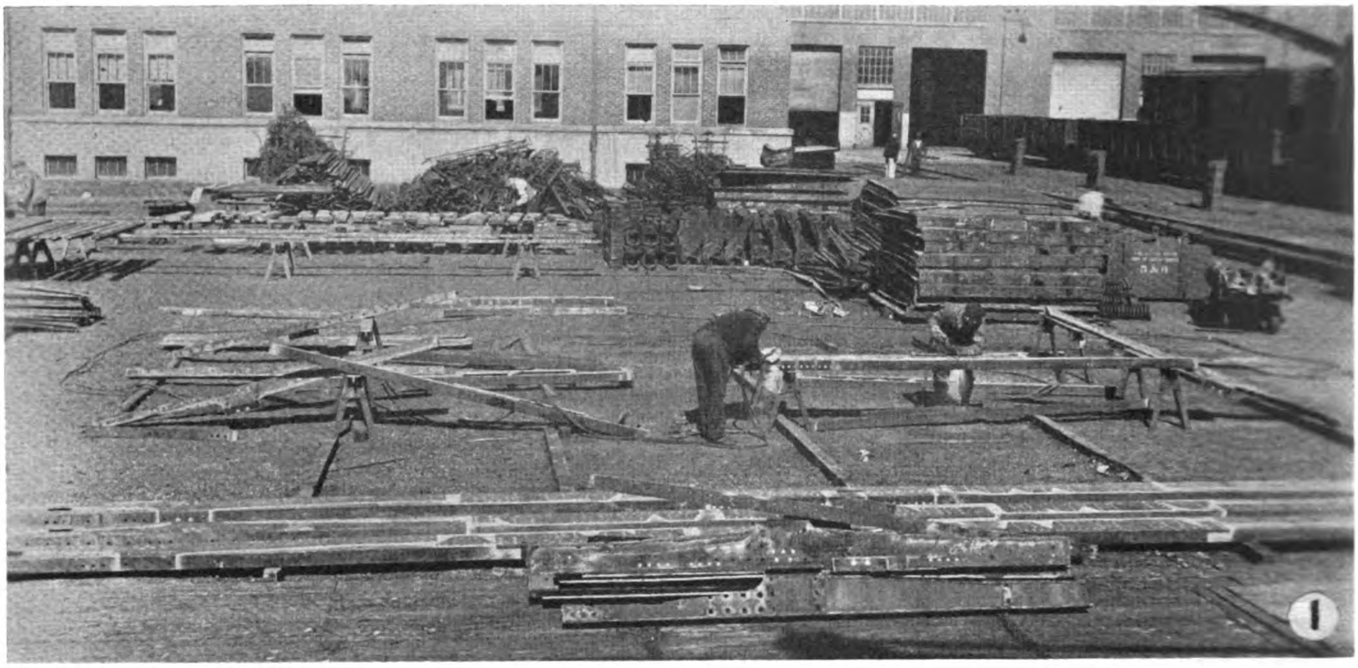


Fig. 1—Many steel parts were laid out with template and spray gun.

Four Weeks to Rebuild 100

Reading Automobile Cars

In 1927 the Reading Company completed a new shop for heavy freight-car repairs at Reading, Pa., and in 1932 inaugurated in that shop the "spot" system of repairs in its present form. The spot system included a coordinated material delivery system, the operation of both of which were described in a joint paper presented at a meeting of the New York Railroad Club on October 20, 1933.*

An excellent example of a major rebuilding operation carried on under this shop system is that of the conversion of 100 single-sheathed box cars to all-steel automobile cars with Duryea cushion underframes and auto loaders.

Description of Cars

The rebuilt cars are known as Class XARA, Series 18,700 to 18,799, of all-steel construction with wood lining, Duryea cushion underframes and Evans auto loaders. The principal dimensions and weights of the cars are as shown in Table I.

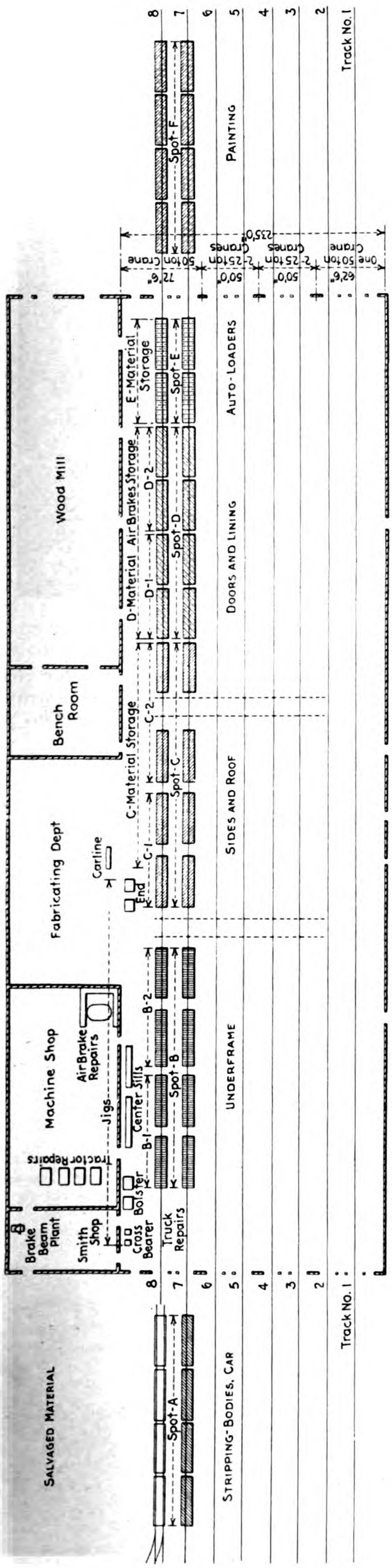
Other specialties on these cars are the AB brake equipment, furnished by Westinghouse; Ajax hand brake; Creco ball-bearing double doors; Alan-wood Super-Diamond steel running boards and roof platforms; Type E couplers, Creco brake beams and bottom rod supports, and the Cardwell-Westinghouse truck springs.

Rebuilding Operations

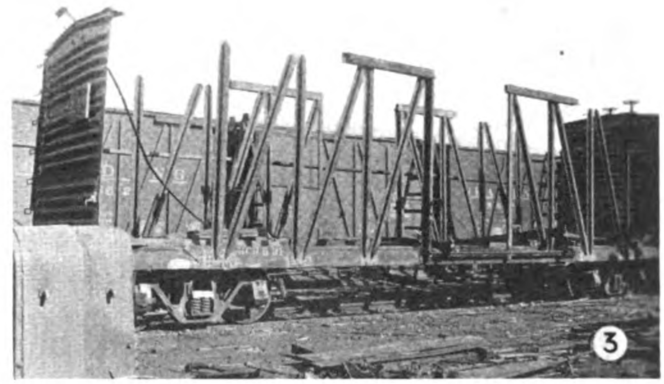
The first car in this series to be completed was turned out of the Reading shop on October 12, 1935, and the last of the 100 cars left the shop on November 9, 1935.

Fig. 2—One of the original single-sheathed box cars before conversion

* The operation of the spot system at the Reading car shops was described in an abstract of the New York Railroad Club paper in the December, 1933, issue of the *Railway Mechanical Engineer*, page 442.



The layout of the shop showing the locations of the several spots



An average output of four cars a day was planned before the work was started and that schedule was maintained without difficulty.

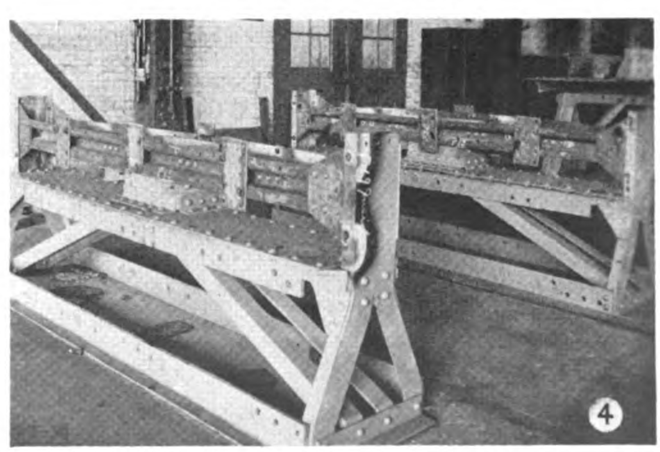
The material used in these converted cars was fabricated in part by the Reading shop and in part by the Parish Pressed Steel Company, Reading, Pa. Those parts fabricated by the railroad company were body bolsters, center sills, cross-bearers, carlines, body ends and miscellaneous gussets and braces. The complete sides, ready to apply the roof sheets, running boards and brake steps were fabricated by the Parish Company and delivered to the shop ready for assembly. With the exception of certain parts of the center-sill assembly the cross-bearers and minor parts, new material was used in these cars.

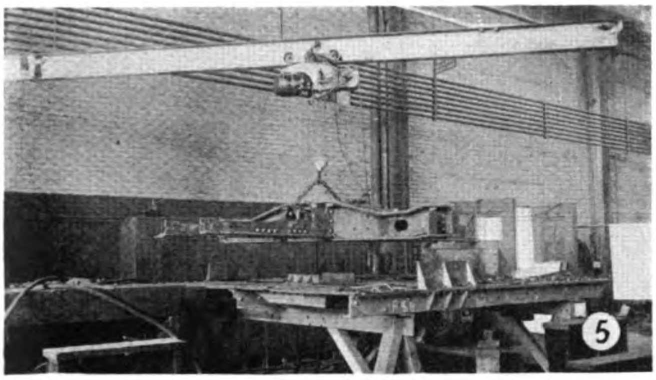
The various operations were performed at six shop

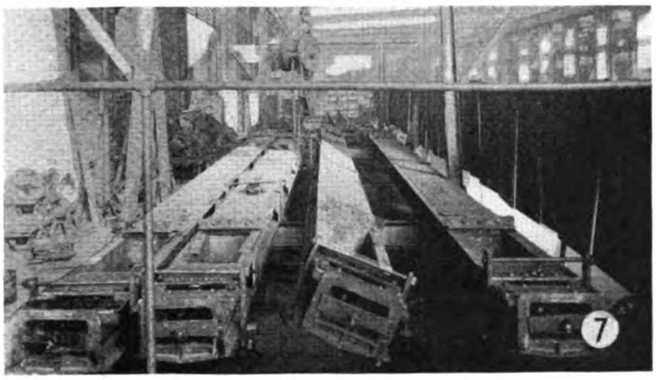
Table I—Principal Weights and Dimensions

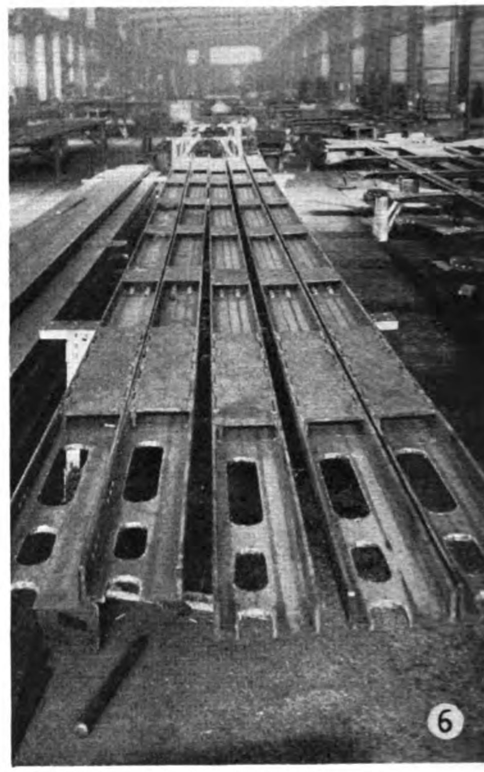
Capacity	100,000 lb.
Light weight	56,500 lb.
Capy. in cu. ft. (with auto loader down)	3,840
Capy. in cu. ft. (with auto loader up)	3,620
Length, coupled	45 ft. 1½ in.
Length, over striking castings	42 ft. 10 in.
Length, inside	40 ft. 6 in.
Truck centers	31 ft. 1½ in.
Truck wheel centers	5 ft. 6 in.
Height, over running boards	14 ft. 8⅛ in.
Height, at eaves	14 ft. 1⅛ in.
Height, inside (with loader up)	9 ft. 9 in.
Height, inside (with loader down)	10 ft. 4⅛ in.
Height, door opening	9 ft. 8⅛ in.
Width, overall	10 ft. 6 in.
Width, over side sills	9 ft. 9⅝ in.
Width, inside	9 ft. 2 in.
Truck type	Andrews
Journal size	5½ in. x 10 in.
Wheels, cast iron, diameter	33 in.

Fig. 3: The stripping process practically complete—Fig. 4: Cross-bearer assembly in the jig









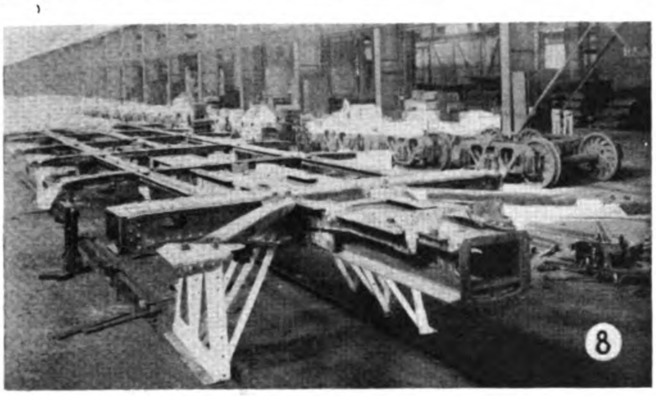
locations or "spots" and each individual car consumed 11 days in passing through the shop, from stripping to final inspection. All operations were timed to produce the average output of four cars a day.

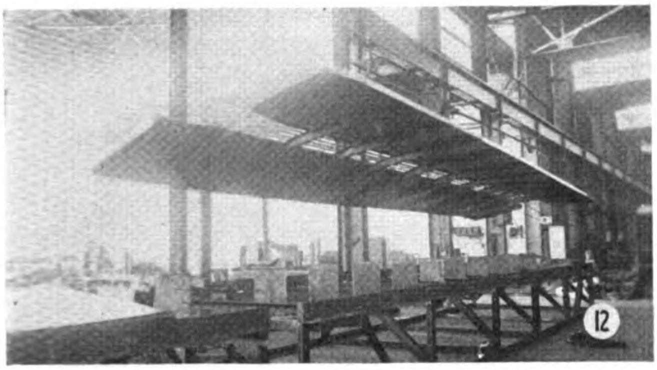
Detail Operations

First Day.—Four cars were taken into the shop at Spot *A* and completely stripped. The material was sorted and sent to scrap or, if to be used over, to the fabricating shop.

Second day.—The assembly operations started at Spot *B-1.* On this day cross-bearers, bolsters and center sills were fitted, welded, reamed and riveted up. Production was simplified by the general use of assembly jigs. Wherever possible the oxy-acetylene torch was used to cut out shapes and Fig. 1 shows how the center-sill channels were laid out with templates by the use of a spray gun and white paint. No center punching was done—even the holes to be punched for rivets were located by a template and the spray gun. The jig for the

Fig. 5: Removing the assembled body bolster from the jig—Figs. 6 and 7: Two views of the work on the center sill—Fig. 8: The underframe assembly—Fig. 9: Assembling the car ends on a special jig—Fig. 10: Applying the carline extension to a carline in the jig—Fig. 11: Welding the brackets for the auto loader to the carlines





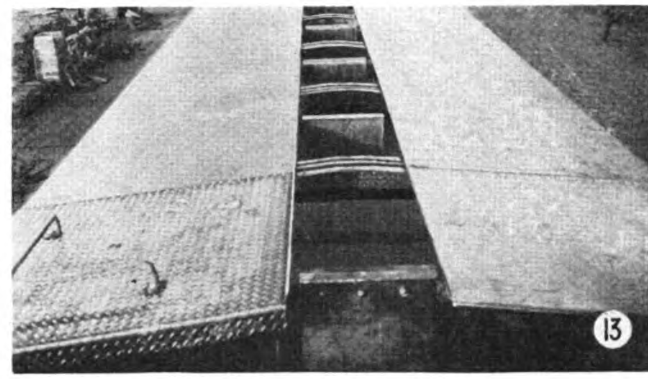
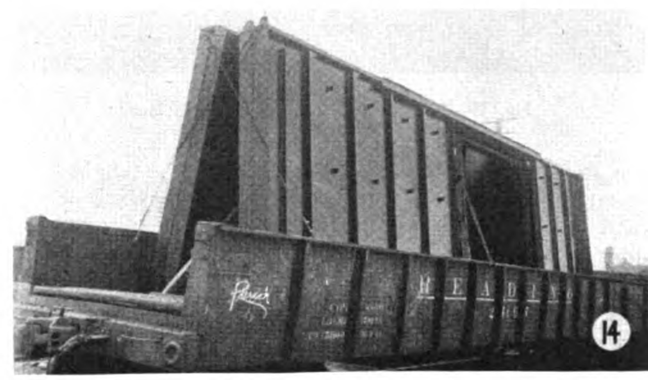


Fig. 12: The roof assembly jig—Fig. 13: The roof sheets in place before welding on the running board—Fig. 14: The fabricated car sides as received at the shop—Fig. 15: Applying the car sides to the underframe—Fig. 16: One of the cars at the completion of the superstructure assembling operation—Fig. 17: Fastening down the metal door sill with an electric screw driver—Fig. 18: The template used for locating the holes to be bored in the floor for the auto loader

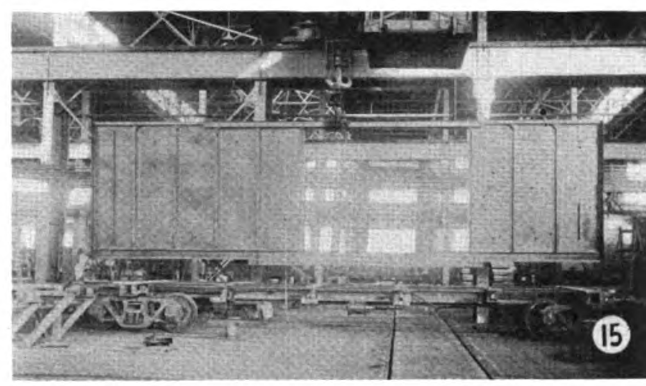


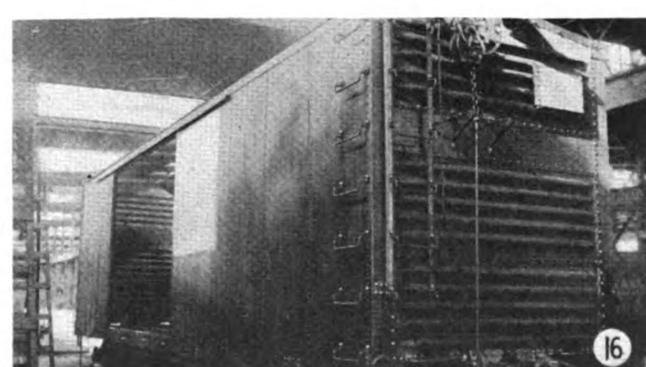
assembly of the cross-bearers is shown in Fig. 4; the bolster assembly is shown in Fig. 5 and two views of the work on the center sills are shown in Figs. 6 and 7. The cross-bearers were fabricated from body side posts and stakes from the old cars, the bolsters were also made from materials from the old cars, except the top and bottom cover plates, which were new. The center sills had new channels and buffer castings with second-hand stiffeners, draft stops, top and bottom cover plates, tie plates and draft-gear carrier plates.

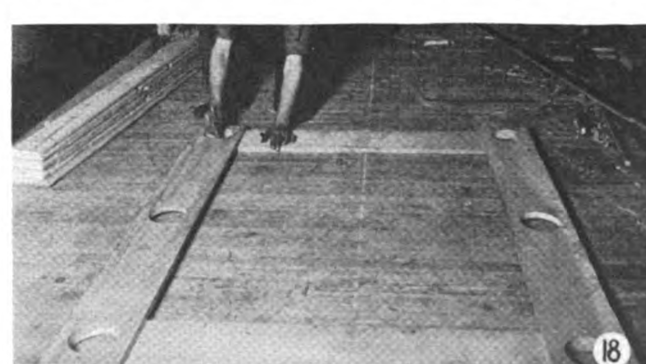
The trucks were overhauled by a separate truck gang at Spot *B* on the second day.

Third day.—At Spot *B-2*, the assembly operations on the underframe were performed. This is shown in Fig. 8.

Fourth day.—At Spot *C-1* the car ends were assembled on jigs as shown in Fig. 9. These ends were from the old cars with extensions riveted between the







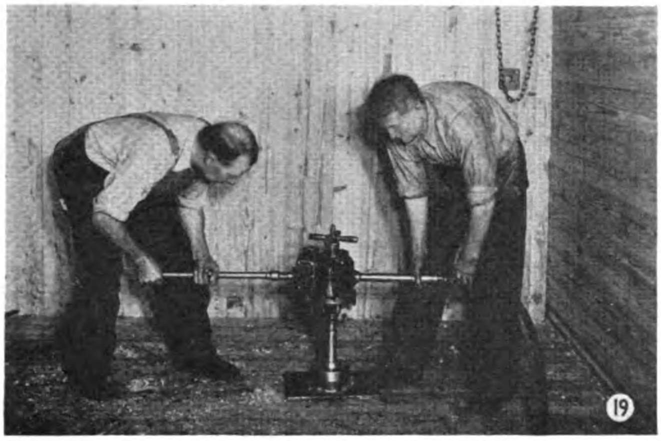


Fig. 19—Boring the holes for the auto loader

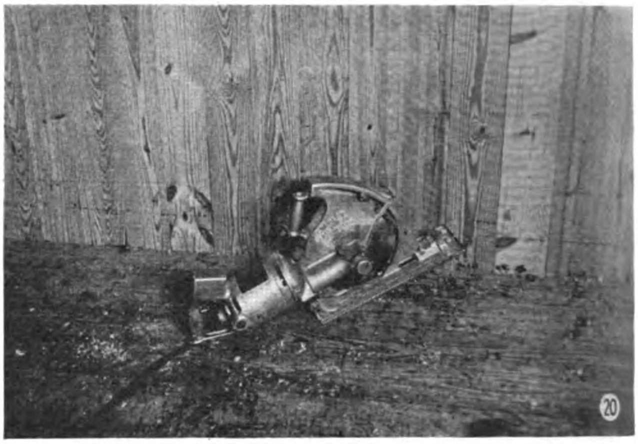


Fig. 20—The power saw for cutting the rectangular holes

top and intermediate sections to increase the height. The assembly of the new car ends on the jigs included the card boards, hand-brake mechanism, brake step and running-board braces and chain hoists for the auto loader.

The job on the roof consisted of the preparation of the carlines by cutting off the ends of the old carlines, riveting on new ends with the aid of the jig shown in Fig. 10 and welding the brackets for the auto loader to certain carlines as shown in Fig. 11. The carlines were then set up in the roof jig shown in Fig. 12 and the roof sheets were riveted to the carlines.

There are three interesting features of the roof construction. The roof sheets on each side are flanged up near the center of the car to receive the Super-Diamond steel running board which, in effect, forms a cap that is welded full length to the roof sheets, making a water tight joint. By this construction an amount of material approximately equal to the running-board area is saved. The other features are the elimination of the corner roof platform by the use of the Super-Diamond steel sheet, and the roof sheets, which run longitudinally instead of across the car. (Figs. 13 and 22.)

The car sides, as previously mentioned, were fabricated outside and delivered for assembly at this point in the schedule. Figs. 14 and 15 show the car sides before and during assembly to the underframe.

At Spot *C-1* the sides and ends were bolted to the underframe, the roof assembly bolted on and the entire body reamed for riveting. This was done at Spot *C-2* on the *fifth day.* Fig. 16 shows the car at the completion of these operations. At this spot the brake equipment and piping were also applied.

Sixth day.—At Spot *D-1,* couplers, safety appliances, door brackets, door tracks and fixtures were applied and the car floors were put in. Fig. 17 shows a workman fastening down the metal door sill by means of an electric screw driver.

Seventh day.—Linings, nailing strips and door posts were applied at Spot *D-2.*

Eighth day.—At this point in the schedule the auto loaders were applied at Spot *E-1.* The installation of each one of these loader units required the cutting of several large round and rectangular holes in the car floor. Formerly it was the practice to establish the location of

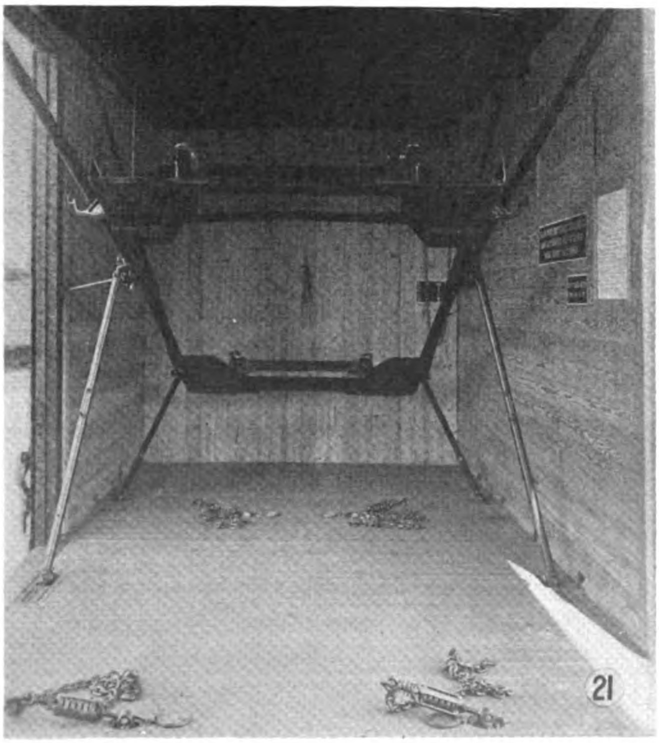


Fig. 21—Interior of the car with the auto loader in place

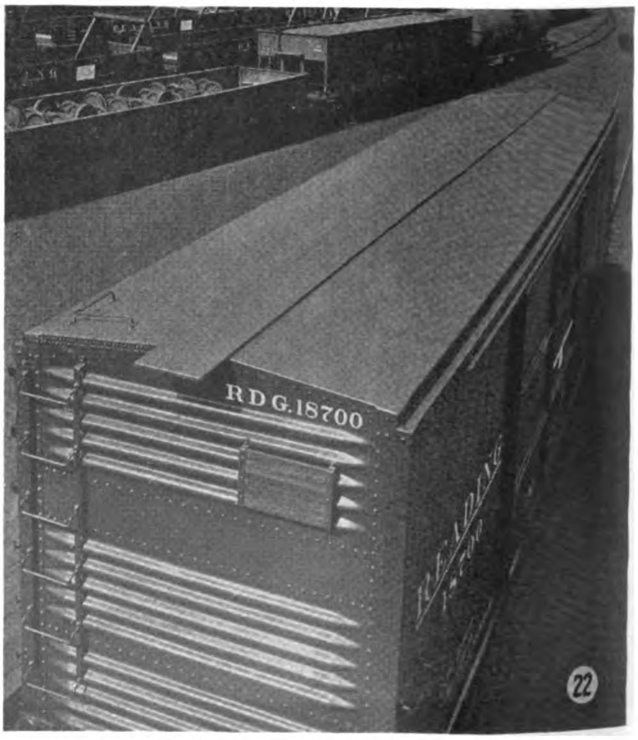


Fig. 22—A top view of the finished car

each hole, bore around a circle or rectangle with a brace and bit and chip out with a hammer and chisel. The method by which it was done on these cars is shown in Figs. 18 and 19. These show, respectively the template for locating the holes and the jig and tool in use, boring the holes. Fig. 20 shows a power saw for cutting the rectangular holes. The loader, installed, is shown in Fig. 21.

On the eighth day, the card boards were applied, the cars given final inspection and air brake tests. They were then ready to leave the shop for painting.

Painting

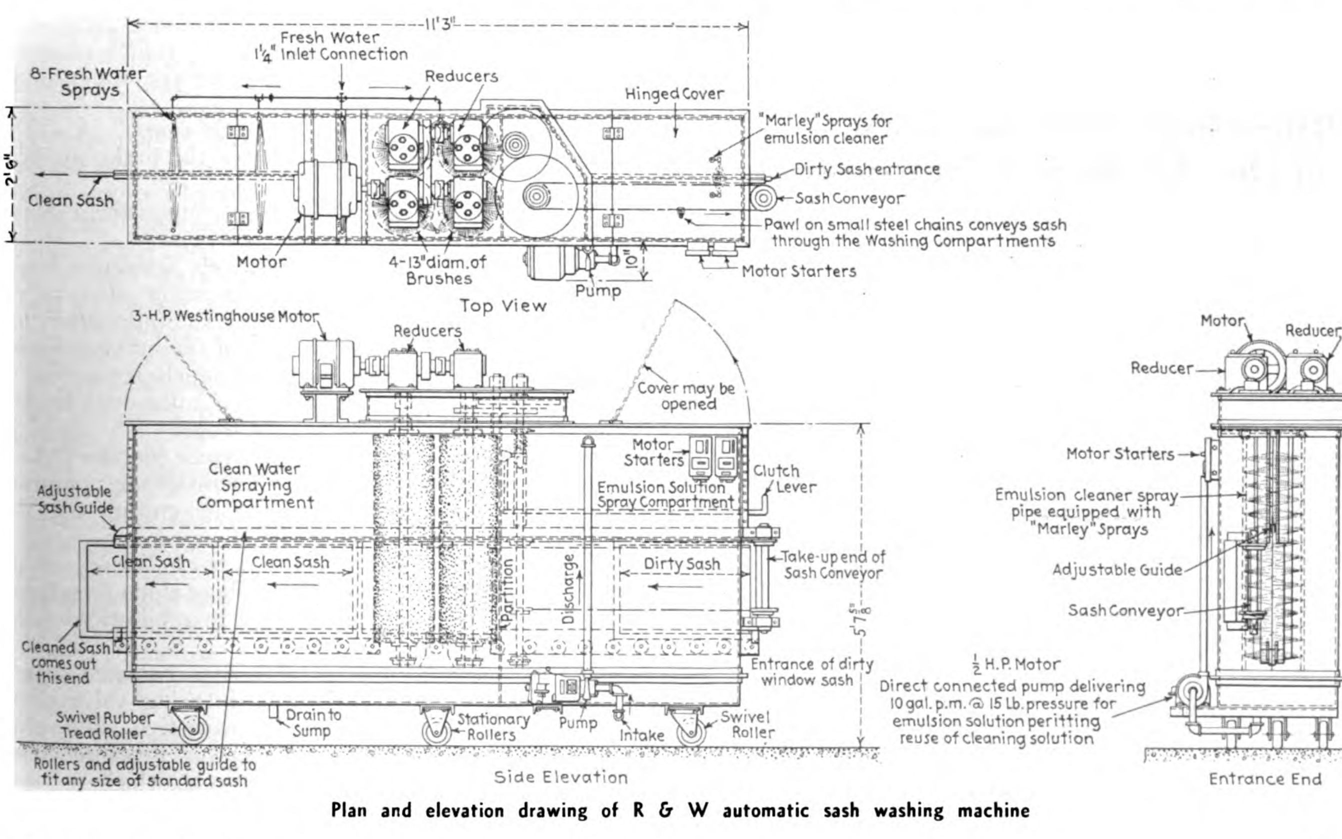
All sheets used in the construction of these cars were given a coat of red lead before assembly and, at Spot *F*, on the ninth day the cars were given a ground or primary coat, by the spray process. On the tenth day they received a finish coat and on the eleventh day they were stencilled. A top view of the finished car is shown in Fig. 22. The entire underframe, the inside of the car ends and 24 in. at the bottom of the sides as well as all laps, joints and the inside and outside of the roof were sprayed with a coat of car cement during assembly. After the paint was dry the cars were given a leakage test, and were then ready for service.

Passenger Car Sash Washing Machine

In addition to its automatic car washer, the Ross & White Company, Chicago, has recently perfected and placed on the market a portable automatic machine for washing passenger car sash at a substantial saving in time and cost over previous hand washing methods. The cleaning of individual sash for passenger cars undergoing repairs at car shops is a routine operation involving considerable expense throughout the year, and, in addition, some railways have to clean as many as 50,000 storm sash within a comparatively short period each fall in preparing passenger equipment for winter service. The sash-washing machine designed to clean sash automatically and thoroughly by electric power in about one minute per sash and at a cost of two cents per sash, which may be compared with five cents per sash for hand washing.

The Ross & White sash washer is designed to be operated by one man who feeds in the dirty windows at the entrance end of the machine and receives the clean, washed windows from the delivery end. The machine consists of a structural steel plate box 11 ft. long, 30 in. wide and 5 ft. 7 in. high, mounted on four 6-in. roller-bearing wheels, two of which are fixed and two, at the ends, arranged to swivel. The box is divided into two compartments, the first of which contains an acid spray for cutting the dirt. The second, or larger compartment, contains the motor-driven cleaning brushes near the center of the machine, and a clean water spraying compartment in the other end.

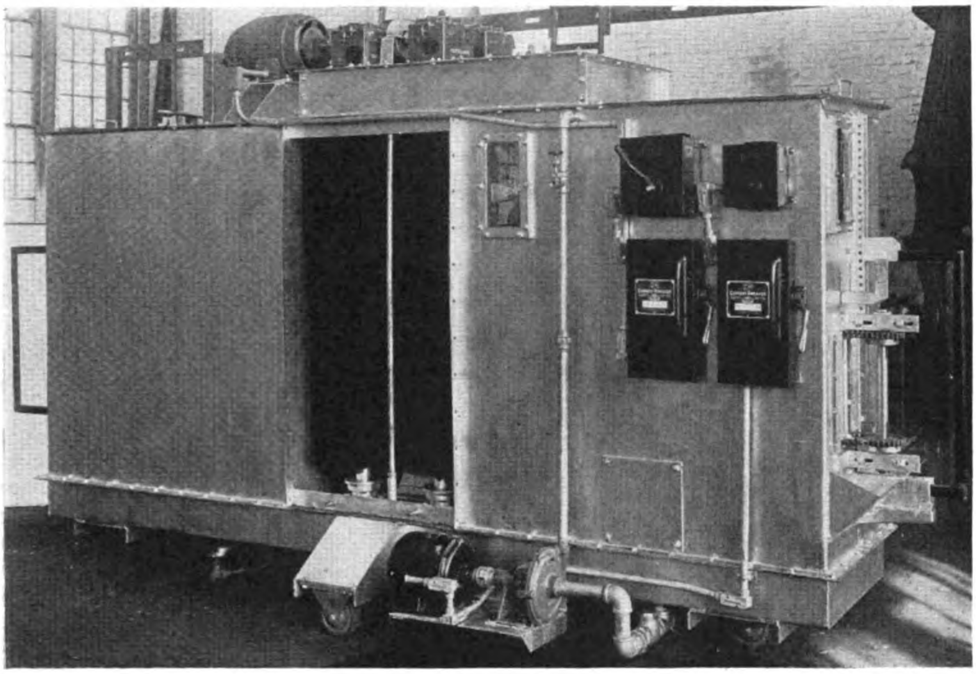
The dirty sash, which can be handled in all sizes up to 42½ in. high, are placed between roller and channel iron guides at the center of the receiving end where they are conveyed forward by a pawl on a moving bicycle chain. The sash are first covered with a spray of Imperial emulsion solution, or other acid if desired, this solution being reclaimed and recirculated by a small, electric, centrifugal pump located on one side of the box near the bottom, as shown in the illustration. The sash are slowly conveyed between four 13-in. diameter, fast-revolving brushes, moving in opposite directions so as to cover all crevices of the sash and thoroughly scrubbing off the dirt. After being pushed through the motor-driven brushes, six sprays of clean water cover the sash thoroughly, cleansing them as they are gradually pushed out of the delivery end of the washing machine. The dirty spray water leaves the bottom of



Plan and elevation drawing of R & W automatic sash washing machine

the water spray compartment through a hose connection to the drain.

An automatic throw-out clutch is provided to start and stop the machine which is readily portable and can be moved from one location to another, receiving its power from an electric line plugged into the starting box. The revolving brushes are driven by a 3-hp. Westinghouse motor through Cleveland worm-gear silent speed reducers. In case the condition of the sash does not require use of the acid spray, this spray can be shut off and the sash run through the machine and thoroughly cleaned by the brushes and water spray alone.



The R & W automatic car sash washer is a compact portable unit

Questions and Answers on the AB Brake Equipment

In response to a desire expressed by a number of readers of the *Railway Mechanical Engineer*, the editor has arranged to publish from time to time a series of questions and answers on the new AB brake which it is hoped will furnish the information which may be desired. Any suggestions as to questions or as to information especially desired will be welcomed. The following is the first installment of the series—Editor.

1—*Q.—Why, at this time, was a more effective air brake required?* A.—Progressive improvements in transportation methods, required correspondingly improved methods of retardation control to enable the safe, expeditious and efficient handling of modern freight trains. Heavier cars, involving greater tonnage per car and per train, together with longer trains, faster schedules and higher speeds, calling for a more effective brake.

2—*Q.—Why was the AB brake developed?* A.—To keep pace with other major improvements, to overcome present limitations of the heretofore standard equipment, and to fulfill present day operating requirements.

3—*Q.—How does this brake compare with the former standard type?* A.—The proved, good operating features of the former brake are retained and other features added, notable among which are forms of construction designed for economical maintenance, and protective devices for the exclusion of dirt. The entire equipment is arranged for installation on the car with a maximum insurance against leakage, and for convenience in cleaning, inspecting, etc.

4—*Q.—In what features have improvements been made in the AB valve as compared with the old type?* A.—Quick-service, release, and emergency positions contain added improvements.

5—*Q.—What improvements have been incorporated in the quick-service features?* A.—Three stages of quick service now provide a prompt and positive brake application on all cars of long trains.

6—*Q.—What happens during the first stage?* A.—The first stage insures prompt starting of the brake application on all cars in the train.

7—*Q.—The second stage?* A.—Insures movement of the piston and slide valve to service position.

8—*Q.—The third stage?* A.—Positively developes brake cylinder pressure of a moderate amount on all cars.

9—*Q.—Does quick service activity continue after the third stage?* A.—No. Full control of the brake cylinder pressure beyond the third stage of quick service is in the hands of the engineman except as influenced by improper and undesired brake pipe leakage.

10—*Q.—What modifies the quick-service function?* A.—The use of pressure retaining valves in grade operation modifies the quick-service function by cutting out the third stage automatically.

11—*Q.—How does this affect the re-application of all brakes?* A.—The first and second stage alone then function to insure a prompt and positive re-application of the brakes.

12—*Q.—What improved features are contained in release position?* A.—(a) A release-insuring valve eliminates delayed release caused by excessive slide-valve friction, by reducing auxiliary-reservoir pressure automatically. (b) An emergency reservoir, which remains fully charged during a service application, is instru-

mental in obtaining a rapid increase of brake-pipe pressure when release is started, due to the fact that the auxiliary reservoir is initially recharged from the emergency reservoir instead of drawing air from the brake-pipe supply. (c) After emergency, the rate of brake pipe build-up is hastened by discharging (during a fixed period of the release operation) brake cylinder and auxiliary reservoir pressure into the brake pipe. The partial restoration of brake pipe pressure from this source assists in the accomplishment of a prompt and positive release.

13—*Q.—What important features are embodied in the emergency position?* A.—(a) Elimination of undesired emergency during a service application, accomplished by a separation of the controlling parts for service and emergency operations. (b) Protection against undesired emergency during release, insured by preventing overcharge of the quick action chamber. (c) Emergency quick action obtainable at any time regardless of the state of service application or release. (d) 20 per cent higher brake cylinder pressure than that obtained from a full service application, the speed of which is 40 per cent faster than with the former standard freight brake equipment. (e) Damaging shocks prevented by the development of emergency brake cylinder pressure in steps.

14—*Q.—Name and describe the general features of the AB brake equipment?* A.—(a) A removable hair strainer (with by-pass protection against stoppage) which serves to lengthen intervals between cleanings by preventing passage of dust particles (too fine to be caught by the dirt collector) to the operative parts of the valve and to the brake cylinder. (b) A duplex release valve, operative from any angle, for bleeding auxiliary and emergency reservoirs. The construction of the valve permits discharge of air from both reservoirs at the same time or the auxiliary reservoir pressure alone. (c) A pipe bracket, mounted on the car permanently, carrying the valve portions and pipe connections so that removal of valve portions does not necessitate breaking pipe joints. (d) Reinforced flanged union pipe connections which support the pipe, providing against brake pipe breakage and loosening of joints. (e) A brake pipe tee with flanged union connections and a lug providing a means of anchoring to the car body. (f) Combined auxiliary and emergency reservoirs into a two-compartment reservoir of sufficient strength to withstand maximum operating pressures. (g) Brake cylinder is fitted with an improved packing not requiring a follower plate, simplifying replacement. Brake cylinder is also provided with a means for continuous lubrication of cylinder walls without opening the cylinder; lubrication of piston rod and protection against entrance of dirt.

15—*Q.—What provision is made for cars exceeding in weight the capacity of the 10-in. brake cylinder?* A.—Parts can be added for use on these cars without change in the operating portions or in the two-compartment reservoir.

Parts of the Equipment

16—*Q.—Name the parts which make up the AB freight car equipment?* A.—(a) AB valve (b) Brake cylinder (c) Two-compartment reservoir (d) Combined dirt collector and cutout cock (e) Branch pipe tee (f) Pressure retaining valve (g) Angle cock on each end of brake pipe and (h) Hose connections and couplings.

17—*Q.—How many portions does the AB valve consist of?* A.—Three.

18—*Q.—Name them?* A.—Pipe bracket (two faced); service portion; emergency portion.

19—*Q.—To what is the pipe bracket connected?* A.—It is bolted to the car underframing, all pipe connections being made permanently to the bracket; service and emergency portions are bolted to it.

20—*Q.—What does the pipe bracket contain?* A.—A removable hair strainer and a quick-action chamber.

21—*Q.—What does the service portion control?* A.—Controls (either directly or through the medium of the emergency portion) the desired charging of reservoirs, also service application and release of brakes.

22—*Q.—What does the emergency portion control?* A.—the quick action feature controlled high brake cylinder pressure and the accelerated emergency release function.

23—*Q.—Is the hair strainer in the pipe bracket the only fixture for catching dirt?* A.—No. Brake pipe air passes through a dirt collector prior to entering the strainer.

24—*Q.—Name and locate the pipe connections on the bracket portion?* A.—Auxiliary reservoir, on upper left; Emergency reservoir on upper right; Brake pipe, lower left; Brake cylinder, lower right; Retaining valve, center.

25—*Q.—How is the brake pipe connected to the bracket portion?* A.—By means of the combined dirt collector and cutout cock.

26—*Q.—How is the dirt collector attached to the bracket portion?* A.—By means of a flange connection cast on the dirt collector.

Service Portion

27—*Q.—Name the operative parts of the service portion?* A.—Service piston, slide and graduating valves, release-insuring valve, limiting valve, back-flow check, release valve, release and application bypass check valves, service piston return-spring and stabilizing spring and guide.

28—*Q.—What is the duty of the service piston?* A.—To operate the slide and graduating valves. It also serves as a dividing line between the brake pipe and auxiliary reservoir.

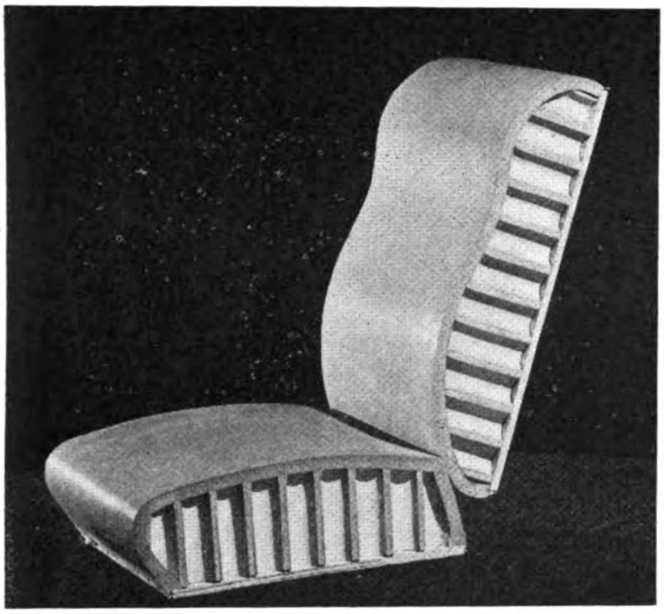
29—*Q.—What is the duty of the service slide valve?* A.—It opens and closes communication between (1) Auxiliary reservoir (service slide valve chamber) and emergency reservoir, past the graduating valve. (2) Brake pipe and quick service volume, through the graduating valve. (3) Brake pipe and brake cylinder, through the limiting valve. (4) Brake cylinder and retaining valve. (5) Auxiliary reservoir and brake cylinder past the graduating valve. (6) Auxiliary reservoir and the inner area of the release-insuring valve. (7) Inner area of release-insuring valve and retaining valve (exhaust).

Latex Cushions and Backs for Car Seats

A type of cushions and backs for the seats of railroad passenger cars and buses formed of vulcanized cellular rubber foam has been developed by the Mishawaka Rubber & Woolen Manufacturing Company, Mishawaka, Ind. Because of the thousands of tiny, intercommunicating rubber cells they have a vibration- and shock-absorbing action said to be several times that of the usual style of cushion. They are likewise completely porous so that in action they are self-ventilating—air constantly being forced through them, in use, thereby keeping them cooler than the conventional cushion.

Other advantages claimed for these cushions include a reduction in maintenance expense because they do not sag or break down; and because they are moulded to the exact shape and size desired, installation cost

is reduced. Likewise because padding and stuffing are unnecessary, trimming cost is reduced to a minimum. In cases where it is desirable to save head and leg room these cushions have an advantage over conventional



Section of Mishawaka seat cushion and back

cushions because they do not need to have similar thickness for equal resiliency and shock-absorbing action.

These cushions are now in use on a number of railroad and bus lines.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Wheels, Loose, Removed by Owner—Joint Evidence Necessary to Establish Improper Repairs

The Illinois Central in rendering a bill against the Southern Pacific charged for new wheels applied to S. P. car 15068, May 20, 1933. Southern Pacific presented billing repair card showing wheels removed at Bakersfield, Calif., December 21, 1933, account wheel loose on axle and requested adjustment under Rule 81. Illinois Central contended that joint evidence per Rule 21, establishing defects necessitating removal must be furnished in support of claim. Southern Pacific claimed this to be unnecessary and failing to agree, the case was submitted for decision.

The Southern Pacific in its statement said that the question at issue was whether or not joint evidence as provided in Rules 12 and 13 is necessary to support claim of loose wheels under Rule 81 when owner's wheel record card showing full information in connection with the removal is matched against billing repair card and wheel record card of the road previously applying such wheels. The S. P. maintains that every purpose is served and all requirements fulfilled by their wheel record card and that it is conclusive evidence that loose wheel was found and replaced. The fact that the exchange was made by car owner does not weaken evidence or require additional support. It is contended that billing repair card and wheel record card of Illinois Central establishes their responsibility under Rule 81.

The Illinois Central in its statement said that their contention was based on last paragraph of Rule 81 which states that car owner is entitled to protection for loose wheels removed within one year of the date of application on basis of wrong repairs. The procedure to be followed in presenting claims for wrong repairs is contained in Rules 12, 13 and 90. The first two rules apply to car owners correcting repairs and it is a requirement of these rules that joint evidence certificate be furnished in support of claim. The last rule, which applies to wrong repairs corrected by an intermediate line, states that repair car on road correcting repairs shall perform the same function as a joint evidence certificate. From the wording of these rules it is clear that all claims of wrong repairs must be supported by joint evidence or equivalent, and there is no rule or arbitration decision that car owner repair cards constitute either of these. It is, therefore, contended that claim of S. P. has not been properly established.

In a decision on April 11, 1935, the Arbitration Committee said: "The Southern Pacific being the car owner in this case, and having removed the loose wheel on its line, should have obtained joint evidence and handled same under Rules 12 and 13 and time limits of Rule 81. The contention of car owner is not sustained."—*Case No. 1743, Rules 12 and 81, Southern Pacific vs. Illinois Central.*

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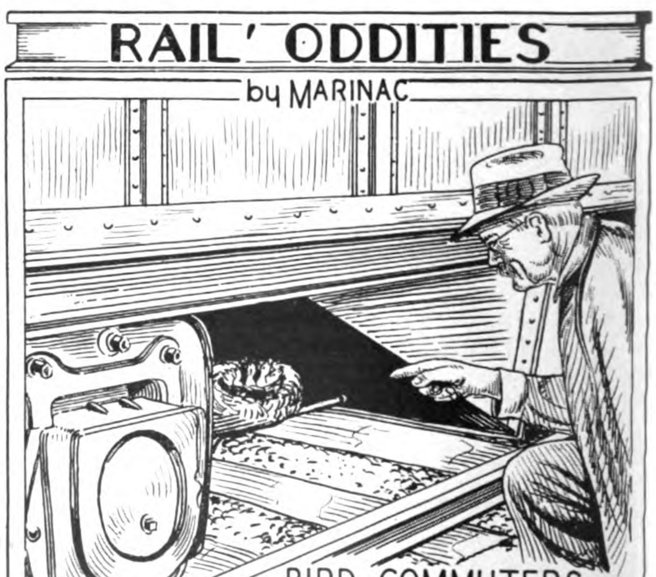


For explanation see page 178

IN THE BACK SHOP AND ENGINEHOUSE

A Mysterious Leaky Throttle

Old timers can tell some tall tales about queer happenings in the shop and roundhouse. Here is one that actually happened not long enough ago to be ancient history for it occurred during the present short-time period. The throttle of a large passenger engine just out of the back shop was continually reported by enginemen to be badly leaking. Whenever this engine was fired up it blew heavily out of the relief valves on the valve chamber and at the cylinder cocks. The throttle valve was repeatedly ground and tested by experienced steam-pipe men, and since the leak continued the general foreman was convinced that there was a hole in the dry pipe, and he personally got inside the boiler and examined the pipe while it was under hydrostatic test—full of hot water at 90 lb. pressure. Everything seemed O.K. including the throttle, throttle box, and standpipe which were tested hydrostatically with hot water outside the engine and again after assembling in the boiler. After the engine was fired up the throttle leaked the same as before, and while the supervisors were having a conference in the office the steam-pipe man (who had been subject to considerable criticism) took out the throttle assembly again. - He made a few measurements and then called the boss over and told him he thought he had found the trouble. He tapped the throttle box with a hand hammer and there was considerable difference in sound on opposite sides. He struck it a sharp blow and broke a three-cornered piece out of it. The casting at this point was only 3/16 in. thick and investigation showed the opposite side to be 1½ in. thick. In pouring the casting the core had got out of center, causing this condition. Under full boiler pressure and temperature the throttle seat went out of round causing the leak.

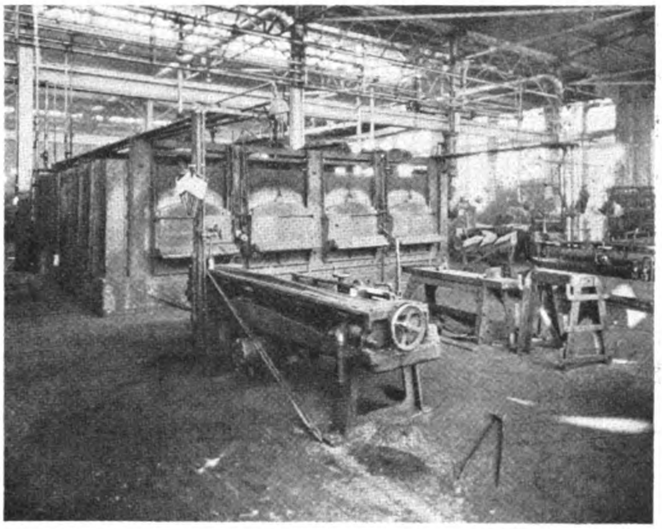
Spring Manufacture At Altoona Shops

*By J. B. Nealey**

At the Pennsylvania's Altoona, Pa., shops, one entire shop is employed in the making and repair of springs—mostly flat springs. These vary considerably in width, thickness, length and number of leaves, and are forged from spring-plate stock.

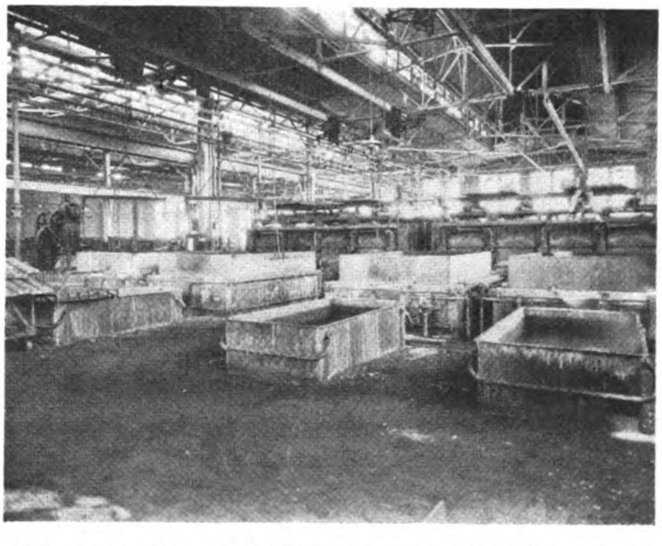
Spring leaves are heated three times, first for forming, second for hardening, and third for drawing. Some are also heated on the ends for nibbing, slotting and trimming. The furnaces are of brick and refractory construction and encased in steel. The two forming furnaces are each 7 ft. by 6 ft. by 18 ft. long and have four doors on the front side, so that the stock can be put in and removed hot from the same side. A row of cast-iron pegs rises above the hearth, along its middle line, and the leaves are placed on edge between these. There is a narrow charging platform and the doors are raised mechanically by tilting a section of this platform. Heat is supplied by 10 gas burners located in the back wall of the furnace.

When heated to approximately 1,800 deg. F. the stock is removed and formed or cambered in the forming machine. This consists of a heavy cast-iron base supporting a chain between pegs. In front is a steel form, curved to conform to the arc of the camber and fixed



The spring leaves are formed at this location

rigidly to the piston of a hydraulic cylinder. The hot stock is put between these and the cylinder forces it against the chain forming it to the right camber. The leaves are then piled on edge in complete spring assemblies on buggies with sloping tops. These are rolled



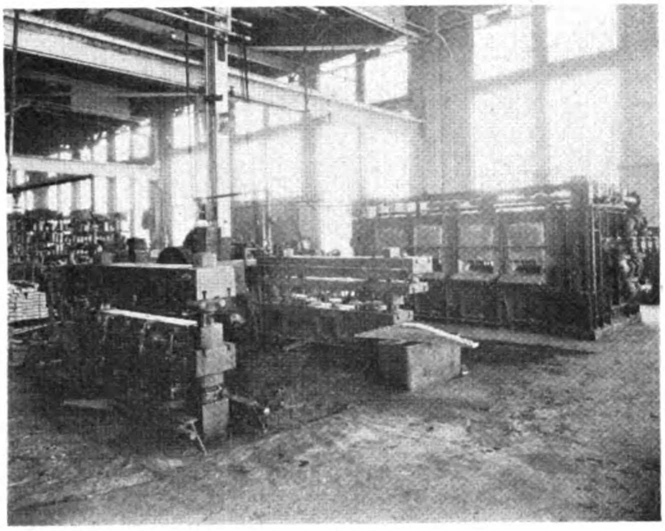
Hardening furnace, salt baths and quenches—Both the oven type furnaces and the salt baths are fired with gas fuel

over to the heat-treating section after allowing sufficient time to cool to black or lower temperature.

The quenching heat is acquired in furnaces (there are two) of the same size as those already described. These furnaces have four doors in each side so that the

*American Gas Association, New York.

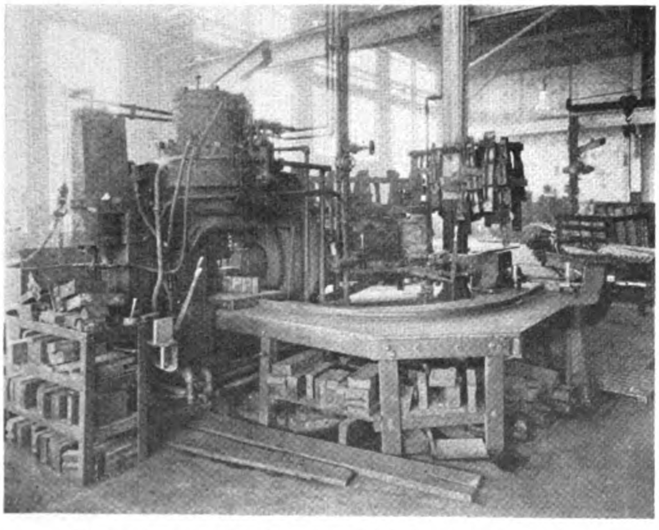
leaves can be put in from one side and pulled out from the other. Heat is supplied by ten gas burners, five in each side and located between the doors and the spaces beyond the two end doors. The burners of all the



Nibbing furnace and press

furnaces are of the inspirator type, each being equipped with a venturi tube. Pressure gas inspirates air in the proper ratio for perfect combustion. The doors are counterweighted and are operated with pneumatic cylinders. A row of pegs occupies the center line of the hearth. It formerly was the practice to lay spring leaves flat in the furnace, after being cambered, but when heating the leaf to the hardening temperature it would lose its camber by virtue of its own weight.

When heated up to 1,500-1,550 deg. F. the leaves are quenched in oil in a row of four steel tanks in the rear of the two hardening furnaces. There is one quenching tank in the rear of each pair of furnace doors. Each tank is 4 ft. by 7 ft. and is equipped with a steel basket with upright spindles between which the leaves are placed. Overhead monorails and hoists transfer the baskets of

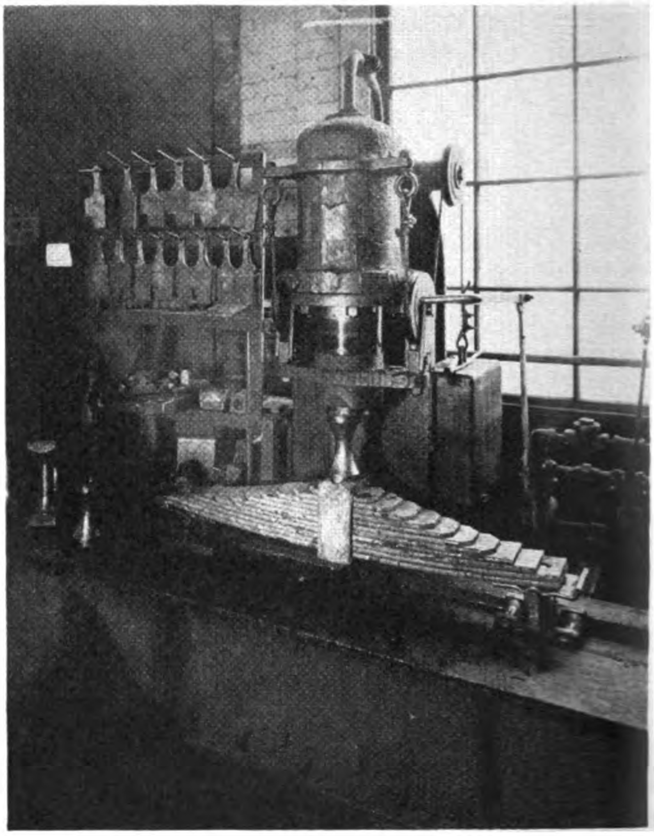


After assembly the springs are banded in this machine

work between the next two operations consisting of drawing and water rinsing. Next to and end to end to the four quenching tanks are four salt baths or kettles set in as many furnaces. The steel kettles are 4 ft. by 8 ft. by 2 ft. deep, and each furnace is fired with two gas burners set in opposite corners and underfiring the kettles. The salt bath consists of a mixture of sodium nitrate and sodium nitrite.

Leaves are quenched in an oil bath in a vertical position and placed in baskets between pins separating the leaves, permitting the free circulation of oil around them and eliminating gas pockets. After the leaves have been quenched the basket is placed in the salt bath, and again this spacing of leaves is of particular advantage as it permits a more uniform draw.

The leaves are reheated to 800 deg. F. in the salt bath and held there for a sufficient time for thorough penetration and are moved to another row of 4 ft. by 7 ft. steel tanks containing water. This acts both as a quench and as a rinse to wash the salts from the work. The leaves



An elliptic spring under the testing machine

are then piled in spring sets on slope-topped buggies.

The final setup requires two gas-fired furnaces, a press for bending bands, and a forging machine for welding the band ends together. The first furnace is 2 ft. wide and 6 ft. long and is heated with a gas burner in each end. It has a slot in the top and this has a refractory baffle suspended just above it. The band stock is of wrought iron or open-hearth welding steel, heated here and formed into U shape in the first hydraulic press. The bands are then reheated and the two ends are turned and lap welded in the forging machine. The second furnace is 2 ft. by 4 ft. in cross section and 6 ft. long. It has four openings in front through which the partially formed bands are thrust for end heating. A single gas burner in each end supplies the heat. These burners are of the pre-mix type and an air blower is part of the combustion equipment. Close by is the assembly bench and as soon as the leaves are put together in spring assemblies the bands are put on hot.

Springs are banded in a 600-ton three-stroke hydraulic press, water being applied during the banding operation to shrink the band into place.

During the banding operation the spring is stencilled

indicating the class of spring, date banded, shop in which repaired and bander's number, so that any defects in banding can readily be traced to the operator who performed the work.

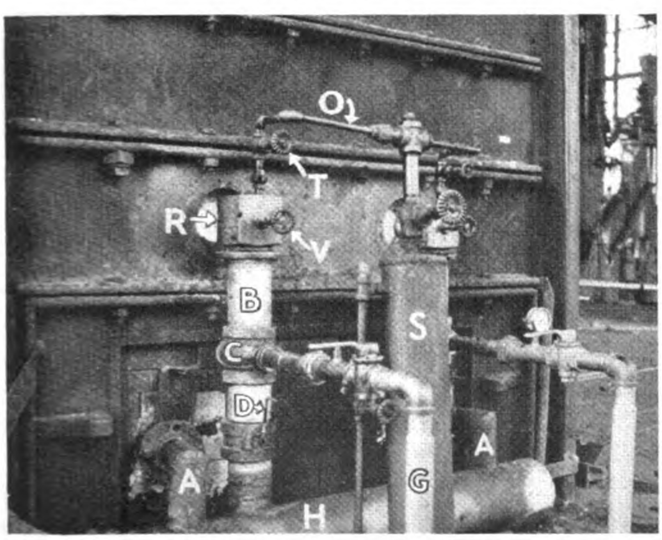
The springs are then carefully gaged for dimensional correctness, tested for free load, maximum load and permanent set, dipped in oil for lubrication and then are either stored or shipped. A large section of the building is given over to storage. Here long parallel lines of steel rails are laid on the floor and the spring assemblies are piled on these. Several parallel overhead monorails with hoists are used to handle them.

Combination Gas and Oil Burner

A combination burner, designed for using either natural gas or oil fuel in railway shop furnaces, has been installed and successfully used, as shown in the illustration, at the Atchison, Topeka & Santa Fe shops, Albuquerque, N. M. The particular view given shows the application of the burner to a large furnace in the blacksmith shop, but two others have also been equipped.

Draft to this furnace is furnished by force blast through an 8-in. header pipe *H*, from which the draft is supplied to the bottom of the furnace through two 3-in. pipes *AA*, one on each side of furnace. This draft lifts the flame over the brick bridge wall and is used when burning either gas or oil.

When using natural gas, the gas is delivered through a 1½-in. gas pipe *G* and a regulating valve in this line at 15 lb. pressure, this pressure being reduced to 5 lb. after the furnace becomes hot. Gas line *G* enters blower pipe *B* at mixing chamber *C*, where it is mixed with air from header pipe *H*. Mixing chamber *C* is so constructed that, in case of a failure of the blower fan, the natural gas cannot pass down into header pipe *H*. Lever *D* in the blower pipe under mixing chamber *C*



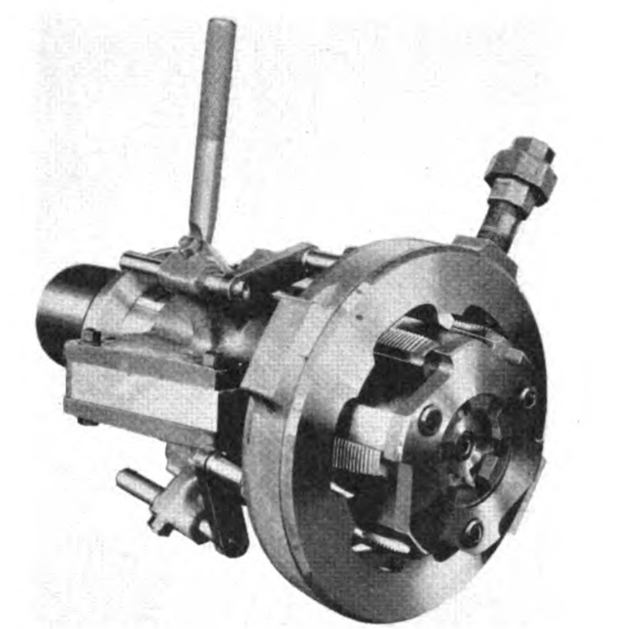
Combination natural gas and oil burner used on large furnace at the Albuquerque shops of the Santa Fe

controls the amount of air passing into mixing chamber *C*, which must be kept within definite limits. Natural gas and air is forced through 4-in. blower pipe *B* into the square regulating chamber *R* which contains a nozzle burner regulated by needle valve *V*.

When using oil instead of natural gas, the valve in line *G* is closed and oil, supplied by a 1¼-in. line passing through heater coil *S*, is reduced by a T-fitting to the ½-in. oil line *O*. Entering the top of square chamber *R*, oil is regulated by valve *T*. It is necessary to change the burner nozzle in chamber *M* when using oil; however, the blast is supplied in the same manner as when burning natural gas. It will be noted that duplicate gas and oil lines are provided, one on each side of large furnaces like the one illustrated.

Oil-Type Trip Ring For Collapsible Taps

When tapping threads, particularly long threads of large diameters in steel, it is essential to maintain ample lubrication to dissipate the heat and wash away the chips. To insure a sufficient supply of lubricant for its line of collapsible taps the Landis Machine Company, Waynes-



Landis 6-in. Style LM receding-chaser collapsible tap with oil-type trip ring

boro, Pa., has placed on the market an oiling type of trip ring to replace the conventional type of ring usually employed on a collapsible tap. The illustration shows one of these rings applied to a 6-in. Landis Style LM receding-chaser collapsible tap. The ring consists of a hollow housing with steel plates mounted on the front and the back, thus forming a reservoir for holding the lubricant. On the smaller sizes of rings the housing is made of cast iron and in order to lessen the weight the housing for the larger rings is made of aluminum. The front ring which contacts the work to effect the receding and collapsing action of the tap is made of steel and case carburized to resist wear.

Holes are placed diagonally in the housing through which a stream of oil is forcibly directed upon each chaser throughout the entire length of the cut, thus insuring ample lubrication at the point where it is needed. A supply pipe with union connection is provided for attaching the supply hose. The housing of the trip ring remains stationary while the front and back plates turn with the tap if it must revolve for tapping the thread.

These rings are available for use with Landis Style LM receding chaser and Style LT collapsible tap, 6 in. in size and larger.

Evans looked up and swallowed his chew of horseshoe. It was the government inspector

Uncle Sam on the Job

by
Walt Wyre

JIM EVANS, roundhouse foreman for the S. P. & W. at Plainville, was making out his engine line-up for the day. "Now, let's see," he reflected as he chewed the end of a pencil. "We can use the 5094 on No. 10. The 5071—I'll run her east on the short end; have to run her over the drop-pit soon as we get the 5087 off," he mused, "driving-boxes are worn past the limit and she needs a new set of tires. Now, that finishes the passenger trains but don't leave much for the freights."

"What you got for 81 and 82?" John Harris, the roundhouse clerk asked.

"When are they doped in?" Evans replied.

"Oh, 81 is figured to get here about three o'clock; 82 ought to make it sometime before midnight."

"Well, if there's not too ~~much on~~ the hog that comes in on 81, we'll just have to make her for 82. I've got two 2800's that ought to be ready for a fire long about three or four o'clock. That just leaves one extra 5000, the 5092, and she's made her mileage long ago and ready for the back-shop. Anyway, here's the list; you can give it to the dispatcher along with my best wishes."

Harris reached for the telephone, but before he lifted the receiver the bell rattled noisily. "Hello . . . Yes, clerk talking." Harris winked at Evans and the foreman knew it was the dispatcher calling. "Yeah . . . Mr. Evans? He's right here." The clerk placed his hand over the mouthpiece. "Train delayer wants to talk to you, Mr. Evans."

"Hello . . . Yes, this is Evans."

"How about a 2800 for an extra west?" the dispatcher asked.

"What time do you want it; and what kind of a train are you going to have?" Evans asked the dispatcher.

"If you'd put in as much time working on locomotives as you do trying to figure how to get them to the other end of the division before they fall to pieces, you wouldn't need to ask what kind of train."

"Well, if you're through making a speech, you might kinda intimate whether you want that hog today or tomorrow," Evans replied sarcastically.

"Well, let's see; it ought to be showing about eleven o'clock, say eleven-thirty. I'll call you back in a little bit and give you something definite. What engine you going to give me?"

"It'll either be the 2870 or 2845. I've got to change a pair of trailer wheels on the 2870 and the 2845 has got the rods down. I'll see which I can get first and let

you know when you call back to let me know when you want it."

"Better call me soon as you find out whether you can get either of them ready or not. How about an engine line-up for the regular trains?"

"The clerk'll give it to you," Evans replied and handed the receiver to Harris.

Evans bit off a hunk of "horseshoe" and hurried out to the roundhouse to see how things were looking. The 2870 had to be run over the drop-pit to change the trailer wheels and had no steam. It would take some time to snake the engine out and shove it over the pit, besides the hostler was busy taking engines around and getting them ready for trains that were called. The 2845 could be worked where she stood and fired most any time. She had more work on her than the 2870, but could probably be gotten out sooner. He decided to use the '45. Machinist Cox and his helper were already working on one side of the engine. The foreman put a machinist and helper on the other side, took a turn through the roundhouse, and went back to the office.

Evans had just settled down comfortably and was looking over work reports when the phone rang. It was the dispatcher.

"Well, what about a hog for that drag?" the dispatcher asked.

"It'll be the 2845. What time is she called for?"

"Eleven-fifteen. Who's the engine crew?"

"Johnson and Murdo." Evans glanced at his watch, eight-thirty-five. "Can't you give us a little more time on it?"

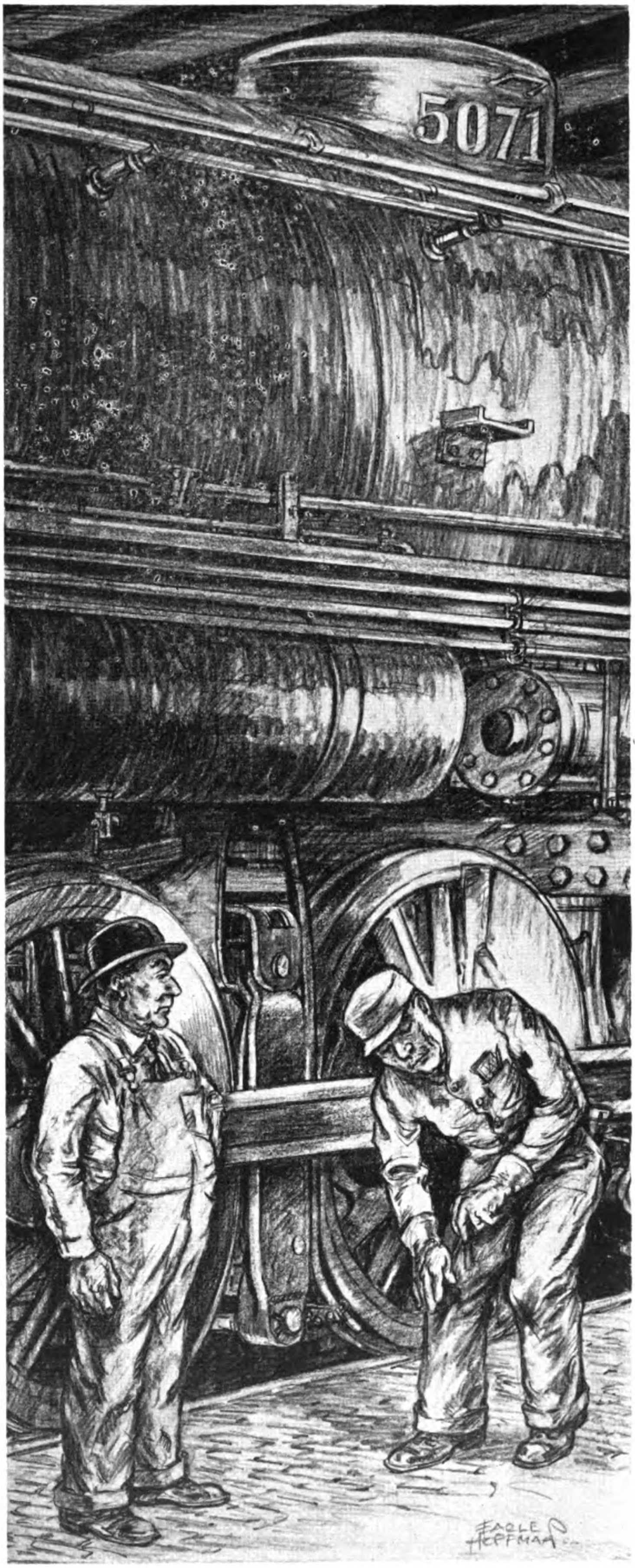
"Nothing doing," the dispatcher replied. "If you'd try having a few engines ready you wouldn't need more time. You ought to know by now that we occasionally use one to pull a train."

"Yeah, and if you'd try guessing right occasionally, we might know what you wanted." Evans grinned as he hung up the receiver.

The foreman again settled himself comfortably and began to look over the work reports trying to figure out what jobs had to be done and ones that could ride another trip. Doing everything that needed to be done was out of the question entirely. Not enough engines to hold them until the work was finished and not enough appropriation to pay the extra men that would be required to do the work if he could.

He had just about finished going over the work reports when the office door swung open. Evans looked up and swallowed his chew of "horseshoe." It was the government inspector.

Jim shoved the work reports aside and rose. The foreman was smiling as he advanced with outthrust hand to greet the government inspector, but the smile was more like the ones seen painted on wax dummies in show windows than of pleasure. Of course the cud of well masticated chewing tobacco doing somersaults in Evans stomach didn't help his feelings. Added to the fact that half the engines he figured on running bore defects that rated a Form 5 if the inspector wanted to get technical about it, Jim wished for a convenient hole to drop in. The way he felt, the hole wouldn't need to be a very large one, either. He felt low enough to walk under a pilot standing up without bumping his head.



He rose and dusted off his knee with a gloved hand. "Looks like too much travel on the driver brakes," he announced

"Well, well, Mr. Turner, wasn't expecting you right now. Glad to see you," Jim lied with the best possible grace under the circumstances. "How are you?"

"Pretty well, thanks, Mr. Evans; managing to keep going and stay pretty busy. How are your engines? How's the spring rigging on them? Last time I was here some of them were in pretty bad shape. Driving-boxes on some of them worn pretty close to the limit, too," the inspector added as he took off his coat and began to put on a suit of unionalls.

The mention of driving-boxes sent a chill down Evans' spine. He thought of the 5071 marked up to run and the 5092 worse than the 5071, if anything, and the 2845. If Turner happened to get started on driving-boxes, the few trains run that day would be bothered very little with meet orders. It was sure one grand time for a government inspector to show up.

"How's the motor car?" Turner asked as he wiggled into his unionalls. Gas electric cars had only been under the government inspector's jurisdiction for a few months.

"Oh, she's all right, I guess," Evans started to add "tied up waiting for a pair of wheels" but changed his mind.

The foreman stood nervously first on one foot then on the other while the government inspector leisurely buttoned up his unionalls then put on a cap and stuck a pair of gloves in a hip pocket. Evans knew Turner. If he, the foreman, appeared to be trying to keep the inspector out of the roundhouse, Turner would be in a bigger hurry to get there. Jim was too sick to stand and afraid to sit down. His stomach was on strike protesting the use of chewing tobacco as food.

THE inspector finished dressing and fished a flashlight from his handbag. That was usually a signal to start for the roundhouse. Jim breathed a sigh of relief for a momentary respite when Turner sat down.

Jim sat down also. "What do you think of the Townsend Plan?" he asked hoping to get the inspector talking. Long as he stayed in the office the inspector wouldn't be finding defects on locomotives.

"Looks like a pretty big issue," Turner replied without interest. "Did you get specifications on making insulation resistance tests on the motor car?"

"Yeah," Evans replied holding his head up with an effort and trying to appear interested. "We've about got straightened out on the motor car. How you finding things over the railroads; conditions any better?"

Machinist Cox who had been working on the 2845 came in at that instant slightly out of breath. "Say, Mr. Evans, there's a crack in the right main pin of the 2845."

"Sure it's a crack?" the foreman asked dolefully.

"Yeah, I 'm sure, that is, pretty sure." Cox had just recognized the government inspector.

"Well, I'll go take a look at it." Jim was glad of an opportunity to get out in the fresh air. "Want to go look at it, Mr. Turner?"

"I'll be out in a little while; going to look the motor car over directly; go ahead."

The main pin was cracked, no argument about it. A hair line of grease showed through the coating of whiting and alcohol with which the machinist had painted the pin. The crack was right up against the fillet on the main rod fit towards the wheel. Not much of a crack, to be sure, but enough for a starting place for the pin to snap off and cause a nasty failure, to say nothing of tying a knot in main and side rods, knocking off the air reverse cylinder, breaking a guide yoke, driving a piston through the cylinder head, perhaps injuring the engineer, or wrecking the train. Any or all of them could happen when a main pin broke with an engine traveling full speed.

"Well, burn it out and tell one of the machinemen to start to work on a new one." Jim's stomach gave a tumultuous heave and he headed for the office.

"Dispatcher said to call him," the clerk told the foreman.

Evans grunted and kept going, headed for the toilet. If he had been a surveyor he couldn't have estimated the distance he could have gone better. One more step and the janitor would have had a job. After unloading the chew of tobacco along with his breakfast and, as Jim thought, part of his interior mechanism, he felt better but his stomach felt emptier than it really was when he remembered about calling the dispatcher. That worthy seemed exceptionally busy when Jim called. Jim waited uneasily nearly five minutes before the dispatcher answered, then instead of the usual line of banter he said, "Be one o'clock on that drag," and hung up.

ANOTHER reprieve, short but sweet. Jim went back to the roundhouse and told the fire builder to get the 5092 hot. He located the hostler and told him to get the 2870 over the drop-pit. At that, the best he could hope for was a couple of hours delay getting the engine ready for the extra. By the time the hostler had shoved 2870 over the drop-pit it was time to get the 5071 out for the eastbound fruit train.

"The fool ought to have sense enough to drag the brakes a little to keep them boxes from pounding," Evans muttered to himself as the hostler brought the 5000 around sounding like a couple of boilermakers in a boiler on payday. The foreman went over to the motor car half expecting Turner to walk over and tie up the 5071 where it stood waiting for the engine crew. He found the inspector puttering around the motor car.

"Want to take a look at the 5071?" Evans tried to appear as though nothing could please him more.

"Just a second, believe I will."

The foreman didn't know whether to write his resignation then or wait until instructed to do so. He decided to wait at least until the 5071 had a Form 5 hung on her. The inspector walked slowly around the locomotive. He didn't appear to be examining anything but Jim knew from experience that his trained eyes were seeing lots—too much, in fact, for the foreman's peace of mind.

Turner stopped. He dropped on one knee between number two and three drivers. Out came his flashlight.

"Take that engine back over the inspection pit," Jim expected to hear him say.

He rose and dusted off his knee with a gloved hand. "Looks like too much travel on the driver brakes," he announced and Evans breathed again.

"I'll have them taken up right now. Like to go out in the house and look over a few?" he added.

"Nearly lunch time now," the inspector replied. "We'll look at them after lunch," he said and started towards the office.

Evans went back to the roundhouse to see how things were coming along there. If he could just get the 5092 out of town, things wouldn't be so bad, especially if Turner finished his inspection before 81 and No. 10 got in. Locomotives on neither of them were exactly in shape for inspecting and if the inspector reported work to be done it would be a good idea to do it before running the engines again. That was another thing Evans had learned from experience.

Jim decided to run the 5092 on the extra. By lingering a little with Turner at lunch there was a chance the engine would get out of town before the inspector had an

opportunity to look it over. It was worth a trial, anyway.

The dispatcher had to be notified of the change. How to get Turner out of the office was another problem. He might accidently get curious. Government inspectors sometimes do when a foreman decides to run an engine that wasn't marked up to run and hasn't been inspected. Evans wrote a note to Harris explaining the situation and instructing him to call the dispatcher after Jim and the inspector had left.

The dispatcher came very near wrecking the plan by calling before Evans and Turner left, but he saved the day in another way.

"They're picking up eight cars of cattle and will want a 5000 for that extra," the dispatcher told him.

"Well, that will be fine," Evans replied.

"I can give you another hour on it if necessary, changing engines on such short notice."

"No, that's O.K.," Evans replied and glanced over at Turner to see if he was listening. If he was he didn't show it.

The dispatcher was so amazed for the moment to find the foreman ready and even anxious to give him an engine on such short notice he almost forgot to ask the number.

"All right, then, called for one o'clock. What's the number?"

The dispatcher was more amazed when Evans replied, "Oh, yeah, that'll be O.K., just like I told you," and hung up. He handed the clerk the note he had written and winked broadly before turning to the inspector.

"Well, are we ready to go eat?"

"I am, but aren't you going to change clothes?"

"Guess I'd better, at that," Evans replied and begain to peel off his overalls at a speed that would have made a fireman jealous. In his anxiety to get the inspector out of the office he had forgotten about taking off his overalls and washing. That didn't delay them much, however, and they were on their way shortly after the noon whistle blew.

The telephone was again rattling insistently as they went out the door. Evans knew it was the dispatcher and knew what he wanted. He pretended not to hear when Turner called his attention to the fact that the phone was ringing.

SMOKE of the 5092 could be seen in the distance when the foreman and government inspector reached the roundhouse after lunch. Things weren't entirely in the clear, though. There was still a dozen or so locomotives marked up to run, any one or all of which could be tied up for Federal defects. True, some of the defects were very slight, but then sometimes inspectors are very critical and become arbitrary over such things as hand rails not clearing over two inches, steam leaks in dynamo heads, clear vision glasses improperly adjusted, and a thousand and one little things that ordinarily they will pass up with casual mention.

They started out through the house about one-thirty, the inspector leading the way, Evans following. As Turner mentioned defects and noted them in his book, Evans wrote them down in a book he carried. The government inspector pointed out defects on engines that the foreman hadn't noticed. At the same time he failed to mention quite a few that Evans knew existed. Occasionally Jim called his attention to defects always adding that it was to be repaired before the engine would be used. Jim knew he wasn't fooling the inspector any and the inspector knew that Jim knew it, too. They had both been on the job too long for either of them to fool the other—much.

(Concluded on page 173)

Diesel Engine Questions and Answers

21.—Q.—*Should the heating coils in a fuel oil tank have any joints?* A.—No. Threaded joints in the heating coil of a fuel tank might leak, allowing water to get into the fuel.

22.—Q.—*What parts of a Diesel engine are the most frequent causes of trouble?* A.—The fuel injection system. The parts of this mechanism take the place of the complicated carburetion and ignition systems of gas engines. By the injection apparatus the timing of the ignition is accomplished.

23.—Q.—*Why are slip joints rather than threaded joints used on the exhaust pipes and mufflers of gas engines?* A.—Slip joints on exhaust piping provide for expansion and contraction.

24.—Q.—*What unusual provisions are made for cooling Diesel engines?* A.—In addition to the cylinder water jacket an oil cooler for the lubricating oil is often used, and on the larger engines oil or water is used to cool the pistons. On some engines the exhaust manifold is water cooled.

25.—Q.—*What is meant when a pump is said to be air locked?* A.—If a pump (for handling liquid) is air locked the body of the pump is full of air which expands and contracts with the operation of the pump. This prevents the valves from working and stops the operation of the pump. Some Diesel fuel pumps are subject to air lock, and provision is made to remove the air by flooding the pump with oil. Air lock is apt to be present after repairs to the pump or piping.

26.—Q.—*What causes the cylinders of a gas engine to wear tapered?* A.—Diesel cylinders wear tapered because there is more pressure under the cylinder packing rings at the compression end of the stroke. When at the crank end of the stroke the cylinder pressure is less and the rings do not set out so firmly against the cylinder wall. Also, high pressure at the compression end of the cylinder causes the piston to press the cylinder wall tightly due to the angularity of the connecting rod. The Diesels used in railway practice have no crossheads.

27.—Q.—*Are step-joint rings superior to diagonally-cut rings?* A.—There is a difference of opinion about the relative merits of different cylinder packing rings. Step-joint rings do not blow through the joint, but like diagonally-cut rings there is some blow of pressure from behind the rings which comes out of the opening at the joint. The thin ends of step-cut rings often break off in service.

28.—Q.—*What is the limiting factor in designing a gas engine for the maximum possible revolutions per minute?* A.—In designing for high speed great difficulty is found in scavenging the burnt gases quickly and completely. This is the reason for superchargers and supplementary exhaust ports sometimes used.

29.—Q.—*Trace the path of lubricating oil through the system of a Diesel engine.* A.—From the sump tank the lubricating oil passes through a strainer to the pump suction, through the pump, through another strainer, through the oil cooler, through the oil lines to the main bearings. It then passes through a hole in the journal of the crank shaft to the center of the shaft, through the shaft to the crank journals, up through the centers of the connecting rods to the piston pins. Oil leaks out of each bearing and falls to the bottom of the crank case where it flows back to the sump tank.

30.—Q.—*What does a supercharger in connection with a Diesel engine accomplish?* A.—A supercharger

operates to put more air into the cylinder by providing a cylinder full of compressed air at the beginning of the stroke instead of air at atmospheric pressure. Since there is more air in the cylinder, if enough fuel is injected the cylinder can develop more power than without the supercharger. The supercharger therefore will enable the power of the engine to be increased, because more air for the combustion stroke is supplied. It does not necessarily increase the efficiency of the engine. Supercharging is particularly desirable when the engine is working in a rarefied atmosphere because it will enable a greater charge of air to be taken in and thus keep up the power. Supercharging is resorted to in aviation engines which operate at high altitudes and this device reduces the power reduction that would otherwise be experienced due to the reduced amount of oxygen present in the charge at high altitudes. A supercharger is useful in giving a reserve of power whenever this may be required. Supercharging may serve to increase the power of an engine at sea level as much as 30 per cent or will give its rated power at an altitude of about 5,000 ft.

New Hy-Draulic Planer Is Announced

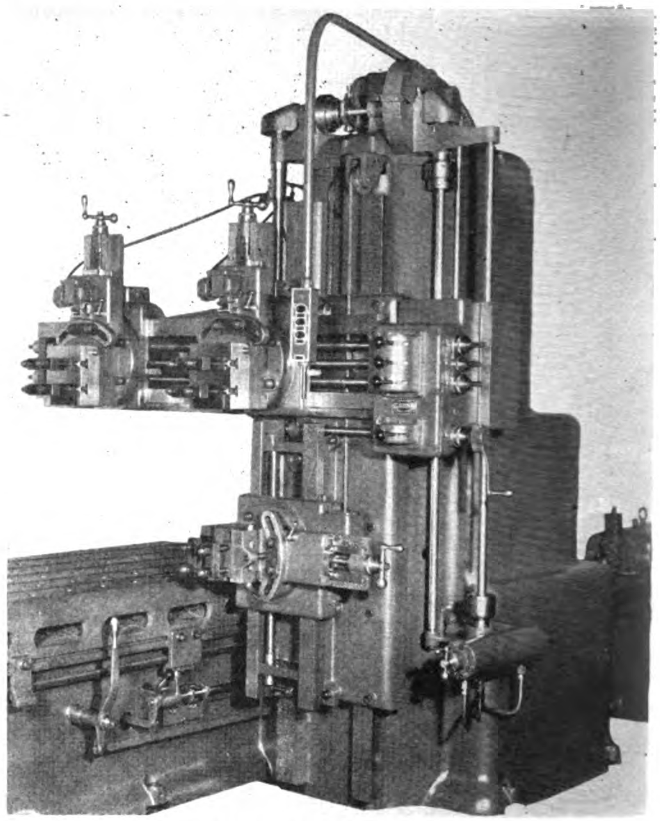
The Rockford Machine Tool Co., 2500 Kishwaukee Street, Rockford, Ill., is now building the Rockford Hy-Draulic planer, in a much larger size than has heretofore been available.

Referring to the illustrations, it will be noted that the "power house" for the machine is at the right-hand end of the bed. This comprises the main driving motor directly connected to the hydraulic power unit, both mounted on a heavy base, and all solidly secured in position. This compact, efficient arrangement is designed to reduce the number and length of the necessary hydraulic connections, eliminate vibrations, provide complete protection, accessibility, and ample ventilation. Hand-wheels on either side of the hydraulic power unit enable the operator easily to adjust cutting speeds and the rapid-return rate.

The double-length box-section bed has heavy ribbing throughout. The table also is box section and has the customary T-slots, hold-down holes, adjustable control dogs, clean-out openings, chip pocket and tool tray at one end with double oil-wipers at both ends for both ways. The table never overhangs the bed.

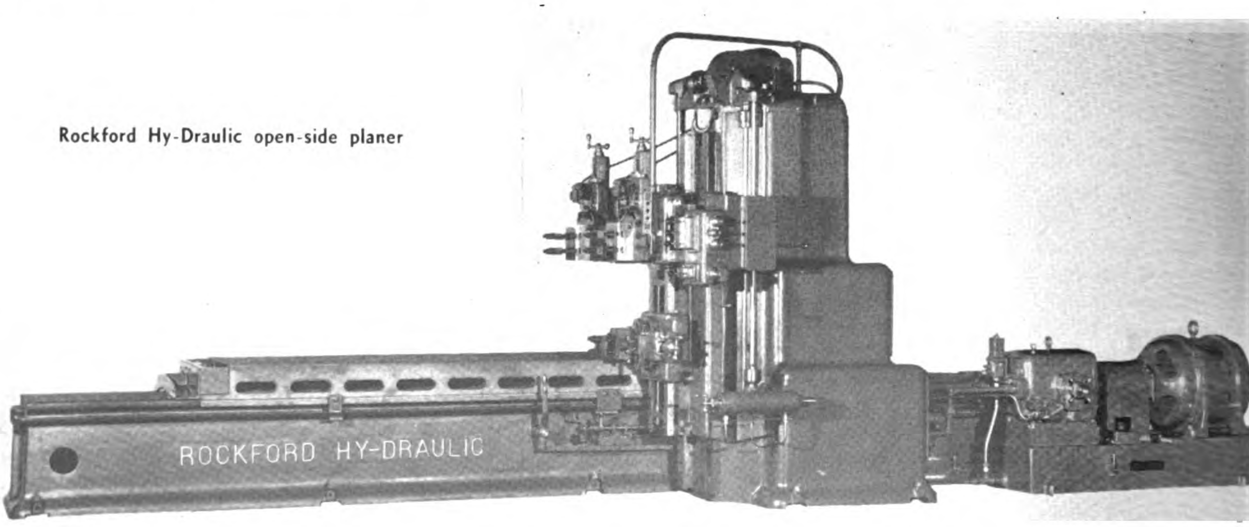
In the center of the machine, there is a massive column which supports the open-side crossrail and contains the electrical and hydraulic control panels. Mounted on top of the column is a motor-driven mechanism which provides rapid traverse to all heads and power elevation for the rail. A large inverted L-shaped casting includes, in one piece, the cross-rail and its long vertical bearing on the column. Securely mounted on this slide is the side-head rail which is pivoted at its upper end and provided with a fine adjustment at its lower extremity. This construction provides a permanent means for accurately aligning the side-head rail which is then solidly secured in position by heavy bolts.

Operating controls are centralized and conveniently located. A pendant contains push-button controls which



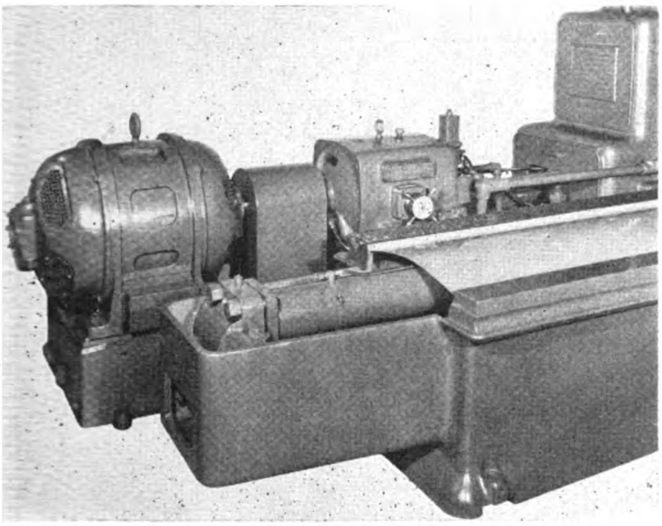
A massive column supports the cross-rail

establish the direction of rapid traverse for the rail-head, a master motor switch, and a rod by means of which the machine can be stopped instantly. Three levers provide complete control for the power-operated



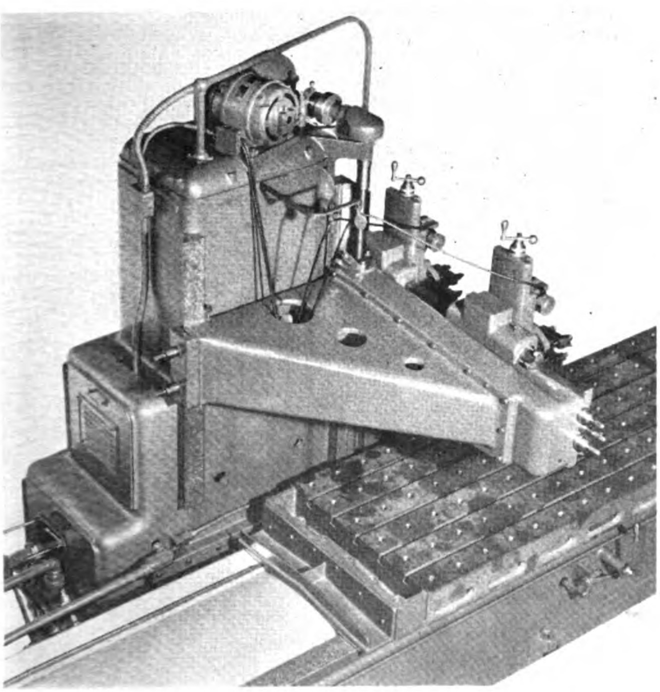
Rockford Hy-Draulic open-side planer

movements of both rail-heads including feed or rapid traverse to left or right, up or down, separately or in unison. A lower lever performs the same service for vertical movement of the side-head. By means of a



Power-house end of the planer

ball crank near the base of the column, the operator can secure instantly any desired feed rate within the capacity of the machine. A lever on the side of the base starts and stops the table movement and an adjacent lever reverses its direction. The rail-heads are equipped with automatic tool-relief devices which raise the tools out of contact with the work during the return stroke. Duplicate controls for starting, stopping, and reversing the table movement are provided on opposite sides of the machine. A heavy sheet-metal cover is



The overhanging cross-rail is firmly braced

provided between the ways which extends the whole length of the bed underneath the table.

The following are general specifications for the machine illustrated:

Maximum pull to table	24,0000 lb.
Maximum distance from table to underside of cross-rail	37½ in.
Length of bed (optional)	23 ft. to 45 ft.
Length of table (optional)	12 ft. to 22 ft.
Width of table	36 in. or 42 in.
Center to center of ways	18⅝ in.
Horizontal adjustment of side-head slide	11 in.
Down adjustment of rail-head slide	11½ in.
Cutting speeds of table per min. (optional)	0 to 50 ft. or more
Return speeds per min. (optional)	10 ft. to 150 ft. or more
Horizontal feed of rail-head	1/42 in to ½ in.
Vertical feeds of rail-head	1/96 in. to ¼ in.
Vertical feeds to side-head	1/48 in. to ½ in.
Horizontal feeds to side-head	Extra

Uncle Sam On the Job

(Continued from page 171)

When the inspector crawled down in the pit under the 5094 Evans just knew he was sunk. It was the only engine available for No. 10, the Limited, for when Turner went under an engine he usually came out with a Form 5 in his hand. This time was an exception.

"Looks pretty good underneath," the inspector said and Jim almost fainted.

"Well, let's go out to the motor car," the government man said.

After inspecting the motor car, the foreman and inspector went back to the office. The inspector began to pull off his unionalls. That meant that he had finished, but it didn't mean what the finish would be. He put away his work clothing and sat down at the desk, Evans sitting across from him. The inspector's black book lay on the table between them. Nearby a well worn brief case lay on the desk, its open side turned so that Evans could see books and papers. One of the pads of paper was blue. Evans had a pretty good idea that up in one corner in small letters was printed "Form 5," the form used to tie up a locomotive until defects were remedied and the locomotive again "safe and suitable for service." Turner filled his pipe, lighted it and puffed until the rough cut was burning evenly.

"When you figuring running the motor car?"

"Not until we get a new pair of wheels for the front truck," Evans replied.

"Yeah, I noticed those wheels. Here's a list of repairs that should be made. Guess I'll go up to the hotel and make out my report." Turner closed the brief case and shook hands with Evans who was congratulating himself on getting away with things in good shape.

"And by the way, Jim. I didn't inspect any driving-boxes *this* trip and the 5092 got out of town before I had a chance to look her over. So-long."

EVANS breathed deeply as he watched Turner walking towards the station. "Thank the Lord for a government inspector with sense," he murmured aloud.

At the same time he knew the inspector had accomplished what he intended to do and knew it. Next trip he'd look at driving-boxes, and they'd be O.K., but something else that wouldn't stand close inspection Turner wouldn't get around to. But pity the foreman that didn't take a tip and get the work done. Form 5's would be thicker than automobile salesmen after ex-service men next July.

HISTORIC LOCOMOTIVE—The London & North Eastern of England has just withdrawn from service a locomotive that was constructed in 1891 in the record time of 9¾ hr. This example of record building was intended to demonstrate how quickly a locomotive could be put together. The engine compiled 1,127,750 miles before being consigned to the Davey Jones' locker of railroads.

Among the Clubs and Associations

WESTERN RAILWAY CLUB.—G. E. Scott, purchasing agent, Missouri-Kansas-Texas, will speak on Purchases and Stores at the meeting to be held on April 20 at the Hotel Sherman, Chicago. A reception and dinner will precede the meeting, which will begin at 8 p.m.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. N. Kelly, manager, United Fruit Despatch Company, will discuss the development of the refrigerator car and its use in banana industry before the meeting to be held at the La Salle Hotel, Chicago, at 8 p.m. on April 13. There will also be moving pictures, with sound equipment.

PACIFIC RAILWAY CLUB.—At its meeting in the Palace Hotel, San Francisco, on March 12, the following officers were elected to serve during the club's twentieth anniversary year: President, Roy W. Hunt, fuel supervisor, Atchison, Topeka & Santa Fe; first vice-president, Homer Bryan, locomotive engineer, Western Pacific; second vice-president, Stuart Daggett, Professor of Transportation, University of California; treasurer, William P. St. Sure, vice-president, East Bay Street Railways, Ltd., and Key West System, and secretary, William S. Wollner, who has served the club as executive secretary since the organization of the club. W. H. Kirkbride, chief engineer of the Southern Pacific, who retired as president, was presented with a past president's locket in appreciation of his services to the club. In addition to the installations there was an illustrated address on Making Railroads and Railroadmen Safe by A. A. Lowe, supervisor of transportation, Southern Pacific.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings and places of meetings of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—T. L. Burton, c/o Westinghouse Air Brake Company, 3400 Empire State Building, New York.

ALLIED RAILWAY SUPPLY ASSOCIATION.—F. W. Venton, Crane Company, Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—C. E. Davies, 29 West Thirty-ninth street, New York.

RAILROAD DIVISION.—Marion B. Richardson, 192 East Cedar street, Livingston, N. J.

MACHINE SHOP PRACTICE DIVISION.—G. F. Nordenholt, 330 West Forty-second street, New York.

MATERIALS HANDLING DIVISION.—F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

OIL AND GAS POWER DIVISION.—M. J. Reed, 2 West Forty-fifth street, New York.

FUELS DIVISION.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

ASSOCIATION OF AMERICAN RAILROADS.—J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

DIVISION I. — OPERATING. — SAFETY SECTION.—J. C. Caviston, 30 Vesey street, New York.

DIVISION V.—MECHANICAL.—V. R. Hawthorne, 59 East Van Buren street, Chicago.

COMMITTEE ON RESEARCH.—E. B. Hall, chairman, care of Chicago & North Western, Chicago.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey street, New York.

DIVISION VIII.—MOTOR TRANSPORT.—CAR SERVICE DIVISION.—C. A. Buch, Transportation Building, Washington, D. C.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEER.—Jos. A. Andreucetti, C. & N. W., 1519 Daily News Building, 400 West Madison street, Chicago, Ill.

CANADIAN RAILWAY CLUB.—C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

CAR DEPARTMENT OFFICERS ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago, 7926 South Morgan st., Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF OMAHA, COUNCIL BLUFFS AND SOUTH OMAHA INTERCHANGE.—J. R. Leach, car department, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p.m. at Union Pacific shops, Council Bluffs.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—E. G. Bishop, Illinois Central System, East St. Louis, Ill. Regular meetings third Tuesday in each month, except June, July and August, Statler Hotel, St. Louis, Mo.

CENTRAL RAILWAY CLUB OF BUFFALO.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

EASTERN CAR FOREMEN'S ASSOCIATION.—E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

INDIANAPOLIS CAR INSPECTION ASSOCIATION.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p.m.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—T. D. Smith, 1660 Old Colony Building, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 West Wabasha street, Winona, Minn.

INTERNATIONAL RAILWAY MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

MASTER BOILERMAKERS' ASSOCIATION.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, excepting June, July, August and September, at Copley-Plaza Hotel, Boston.

NEW YORK RAILROAD CLUB.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

NORTHWEST CAR MEN'S ASSOCIATION.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium Building, St. Paul.

PACIFIC RAILWAY CLUB.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately—June, in Los Angeles and October in Sacramento.

RAILWAY CLUB OF GREENVILLE. — J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

TORONTO RAILWAY CLUB.—R. H. Burgess, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August.

WESTERN RAILWAY CLUB.—C. L. Emerson, executive secretary, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

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For explanation see page 178


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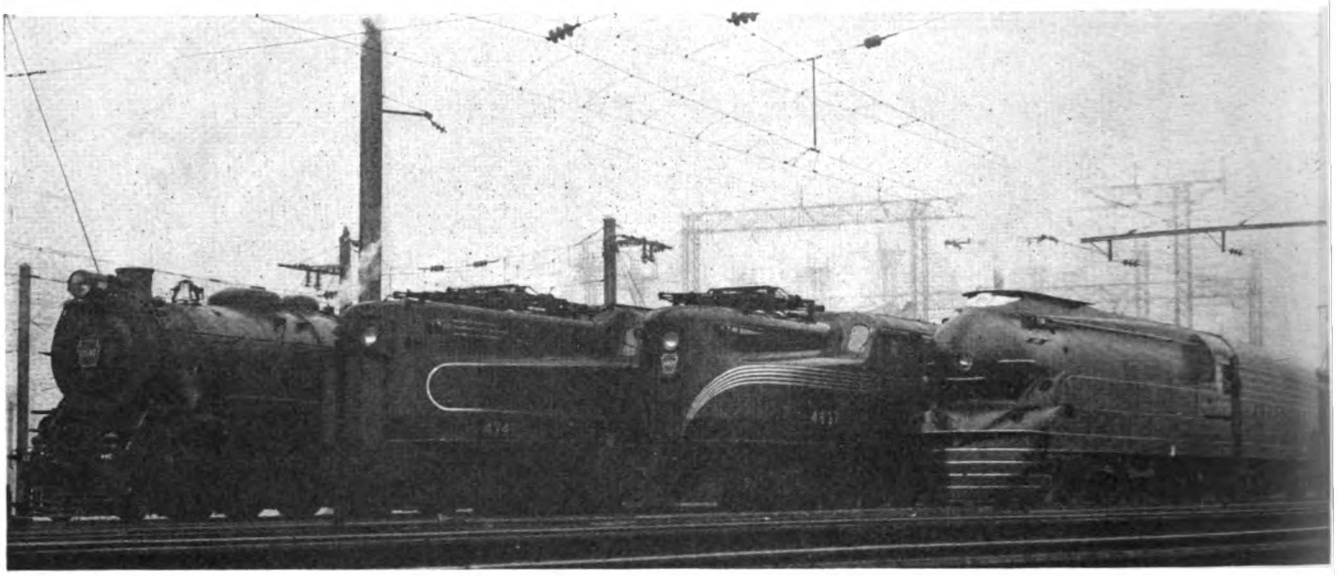

Pennsylvania passenger motive power—K4s Pacific type (left), P5a and GG1 electric locomotives and the new streamline K4s Pacific type

NEWS

Air Resistance of Passenger Trains—A Correction

UNDER Figs. 15 and 16 in the article on Air Resistance of Passenger Trains in the December issue of the *Railway Mechanical Engineer* is the caption "Drag factor curves for the streamlined locomotive trains." The caption under Fig. 16 should have been "Drag factor curves for the standard locomotive trains."

Experimental Devices Not Within Boiler Inspection Act

IN an action against the Southern Railway for the death of the driver of the engine of a fast train in a derailment, the Supreme Court of the United States holds that where a mechanism known as Wright's Little Watchman, designed to stop trains or derailment, is attached to a locomotive it does not become a part or appurtenance thereof which the carrier is absolutely bound properly to maintain, under the Boiler Inspection Act, the evidence showing that the mechanism is in the experimental state. The court said: "With reason, it cannot be said that Congress intended that every gadget placed upon a locomotive by a carrier, for experimental purposes, should become part thereof within the rule of absolute liability. So to hold would hinder commendable efforts to better conditions and tend to defeat the evident purpose—avoidance of unnecessary peril to life or limb.

"Whatever in fact is an integral or essential part of a completed locomotive, and all parts or attachments definitely prescribed by lawful order of the Interstate Commerce Commission, are within the statute. But mere experimental devices which do not increase the peril, but may prove helpful in an emergency, are not. These have not been excluded from the usual rules relative to liability." Judgment for plaintiff was reversed.—Southern v. Mrs. Olivia Cox Lunsford, Admx. Decided March 2, 1936. Opinion by Mr. Justice McReynolds.

New Equipment

LOCOMOTIVE ORDERS

Road	No. of locos.	Type of locomotive	Builder
Great Lakes Steel Corp.	1	73-ton, 6-wheel fireless steam	H. K. Porter Co.
Northern Pacific	12	4-6-6-4	American Loco. Co.

LOCOMOTIVE INQUIRIES

Alton & Southern	1	2-8-2	....
Louisiana & Arkansas	5	2-8-2	....
New York Central	7	Diesel-elec.	....

CAR ORDERS

Road	No. of cars	Type of car	Builder
Charles Lennig & Co., Inc.	1	50-ton tank	General American Trans. Co.
	1	30-ton	
Great Northern	500	Ore	American Car & Fdry. Co.
Wyerhaueser Timber Co.	75	50-ton logging	Pacific Car & Fdry Co.

CAR INQUIRIES

Erie	500	50-ton box	....
	300 [1]	50-ton auto	....
N. Y. C. & St. L.	500	50-ton box	....
	200	50-ton gondolas	....
	50	50-ton flats	....
	25	70-ton gondolas	....
	2	100-ton flats	....
Seaboard Air Line	125	70-ton phosphate	....
Pacific Fruit Express	3,000	Refrig. or underframes	....

[1] 100 to be equipped with loaders.

Air Conditioning

THE Atchison, Topeka & Santa Fe will air-condition 125 passenger cars.

The Missouri Pacific will continue its program of air-conditioning passenger equipment on a schedule providing for the conditioning of substantially all Pullman and coach equipment by July 15. While all principal trains are now so equipped, this year's program, when completed, will find practically every regular car in service air-conditioned and only a few remaining extra cars to complete the entire program. Approximately $918,000 will be expended this year in air-conditioning 93 additional passenger-carrying cars, of which 60 are railroad-owned and 33 are the property of the Pullman Company. The total number of air-conditioned cars in service on the Missouri Pacific, upon the completion of these 93, will be 328.

Special attention is also being given to modernizing the seating equipment, washrooms and lighting of coaches. An innovation in the equipment of coaches will be lunch counters for colored patrons. New effects in lighting are also to be installed

(Turn to next left-hand page)

for the convenience of passengers at night and coach passengers are now ticketed through to avoid disturbance during the night hours.

Orders for air-conditioning equipment placed with the Pullman-Standard Car Manufacturing Company are: Northern Pacific, eight mechanical sets, to be installed in company shops; Minneapolis, St. Paul & Sault Ste. Marie, Pullman mechanical units for four solarium cars and Waukesha Motor Company mechanical units for three diners, all installation to be done in Pullman shops; Chesapeake & Ohio, mechanical units and installation for six coaches.

I.C.C. Modifies Rules for Locomotives Other Than Steam

THE Bureau of Locomotive Inspection has sent out a circular covering modifications which have been made in the Rules and Instructions for the Inspection and Testing of Locomotives Propelled by Other than Steam Power, which will become effective May 1, 1936. These changes cover rules relating to hot water heating boilers in addition to steam heating boilers, provide that fuel tanks shall be equipped with gages indicating the level of the fuel and with suitable vents, also a few other changes to provide more adequately for certain requirements. A revised edition of the Rules is being printed and will be available in about 60 days.

Rule 205 (b)—The range in setting of governors for starting and stopping air compressors has been changed from 2 lb. to 5 lb.

Rule 213 (b)—Location of stampings on axles no longer specifies to be "on one end."

Rule 223 (a)—An additional clause relative to center plates for motor trucks provides that they shall be securely fastened and maintained.

Rule 229 (c)—Specification covering width of hinged cab windows has been omitted.

Rule 252—Revised rule provides that voltmeters and ammeters on units receiving power from outside sources shall be tested every six months (as at present), and on units driven from power generated within the unit every 12 months.

Rules 256 (a) and *323 (c)*—Provisions now specify that fuel reservoirs shall be filled and vented only from outside of the cab or compartment and that vent pipes shall not discharge on the roof nor on or between the rails. Revision also specifies that a fuel reservoir shall be equipped with a gage indicating the level of the fuel and that such gage shall be located so as to be readily visible to the person filling the reservoir.

Rule 302 (d)—A new clause limits the working pressure of cast iron boilers to 15 lb. per sq. in.

Rules 303 (b), 308, 309, 316, 317, 320—Rules have been amplified to include hot water boilers as well as steam boilers, and to include specifications for the application of water relief valves to hot water boilers. These rules cover testing, washing, and etc., of both types of heating boilers.

I. C. Diesel-Electric Locomotive

THE first of three Diesel-electric locomotives has been delivered to the Illinois Central for operation in freight transfer service between Chicago and Markham Yard. It will make a round trip a day, supplanting two steam locomotives required for the same service. The first locomotive, No. 9200, built by the General Electric Company at Erie, Pa., has two 900-hp. Ingersoll-Rand oil engines. Driving motors on the two six-wheel trucks can be operated from cabs in either end of the locomotive. It is expected the locomotive will haul 62 forty-ton cars at a speed of 24 m.p.h. or 125 forty-ton cars at a speed of 13 m.p.h. The locomotive is 60 ft. long, 10 ft. wide, 15½ ft. high, weighs 342,000 lb., and costs $195,000. Its maximum tractive force is estimated at 102,600 lb., dropping to 39,800 lb. at 13 m.p.h.

Improvement Programs

THE Chesapeake & Ohio will repair 1,700 steel hopper cars of 70-tons' capacity this year at its Russell, Ky., shops. This work will require about 7,000 tons of steel which will be furnished by the car builders.

The Delaware & Hudson will build 50 composite hopper cars of 50 tons' capacity in its shops at Oneonta, N. Y., and during the year will rebuild 100 coal cars.

The Norfolk & Western will spend $5,000,000 on an improvement program, including the construction at Roanoke, Va., shops of 1,000 coal cars and 5 Mallet locomotives; extension of yards at Roanoke and at Williamson, W. Va., and additional sidings and yard facilities on its Buchanan branch.

The Western Pacific has asked permission from the Interstate Commerce Commission to issue $3,000,000 of trustees' certificates to be used in connection with its $3,900,000 program to be spent for deferred and normal maintenance and new equipment, including rebuilding 50 freight cars, rehabilitating 500 cars, air-conditioning 4 passenger cars, replacing arch-bar trucks with modern trucks on 1,000 cars and purchase of 100 steel hopper cars. The 100 steel hopper cars have been ordered from the American Car and Foundry Company.

The Lehigh Valley has authorized the construction in its own shops of 250 composite coal cars of 50 tons' capacity to be built of all new material; 250 composite and 500 all-steel 50-ton coal cars to be built of new and second-hand material. The 500 composite cars will be constructed at Sayre, Pa., and the 500 steel cars at Packerton, Pa. The cost of constructing these cars is being partly financed through the aid of the Federal Emergency Administration of Public Works.

Supply Trade Notes

JOSEPH L. NOON, eastern railway sales manager of The Glidden Company, at Reading, Pa., has been appointed manager of railway sales with headquarters at Cleveland, Ohio.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY on April 30 will return its New York executive and sales offices from 30 Rockefeller Plaza, New York, to its former location at 150 Broadway.

THE INTERNATIONAL NICKEL COMPANY, INC., New York, has established field representatives at Chicago and Los Angeles,

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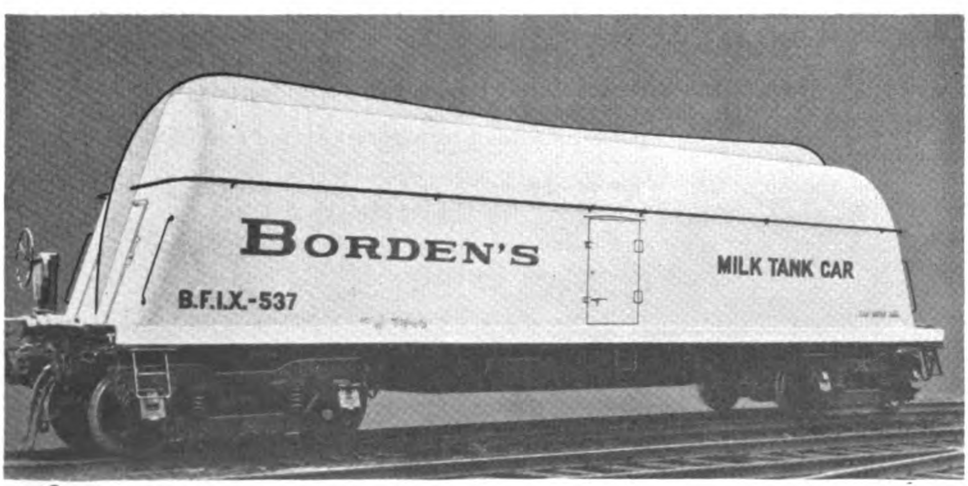

STREAMLINE MILK CAR.—The Borden Farm Products Company, Inc., is rebuilding its wooden tank *milk* cars and giving them a streamline appearance. These cars contain two 12,000 gal. glass lined milk tanks insulated with 6 in. of cork. They are of all-steel construction and arranged for passenger-train service. The sheathing consists of No. 10 gage steel sheets welded to the underframe and then sprayed with two coats each of molten zinc and molten aluminum. By rebuilding weight was reduced from 90,000 lb. to 84,000 lb.

Cal. H. L. Geiger is located at 333 North Michigan Avenue building, Chicago, and A. G. Zima in the Petroleum Securities building, Los Angeles.

Harold T. Henry, eastern district sales manager of the Q & C Company, New York has resigned to become manager of railroad sales of the Burden Iron Company, Troy, N. Y.

The Dampney Company of America, Boston, Mass., has opened a branch office at 220 Bagley avenue, Detroit, Mich., in charge of C. M. Boling, who was formerly resident engineer at Cleveland, Ohio.

The R and C Company, C. D. Hicks and W. E. Hicks, 1218 Olive street, St. Louis, Mo., have been appointed southwest representatives for the Wilson Engineering Corporation, Chicago.

Francis Hodgkinson, consulting mechanical engineer of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has retired after 42 years of service with the Westinghouse Company.

J. R. C. Hintz, until recently railway sales division manager of the Detroit Graphite Company, has been appointed eastern sales representative of the Acme White Lead & Color Works, Detroit, Mich., with headquarters in New York.

L. F. Sweeney has been appointed assistant to the vice-president of the Standard Stoker Company, Inc., Chicago, vice C. T. Hansen, who has been appointed district sales manager, in place of R. J. Schlacks, resigned.

Franklin C. Vandervort, Jr., has again become associated with Johns-Manville Sales Corporation, with headquarters at Chicago. Mr. Vandervort was formerly associated with the Transportation department, and is now re-entering the Johns-Manville service as representative in the western region of its sales organization.

The Heywood-Wakefield Company, Gardner, Mass., has leased the entire east end of the first floor at 1 Park avenue, New York City, which was temporarily occupied by the company. At this address the company will maintain displays of its regular furniture lines, also of railway and bus seats, etc. The offices of its Railway Sales division and New York sales offices will be located at this address.

Daniel B. Worth has joined the locomotive department of the Cummins Engine Company, Columbus, Ind., and his duties will be directly connected with that department. Mr. Worth was formerly associated with the Baldwin Locomotive Works and he has a wide experience with many types of internal-combustion engines as applied to railroad use, his previous work having been in designing, building and servicing such equipment.

Alfred Musso, of New York, and Robert Kemp, of Troy, N. Y., and O. A. Van Denburgh, of Troy, have been elected president, vice-president and secretary, respectively, of the Burden Iron Company, Troy, N. Y. Arthur E. Swan, former chief engineer of the Crucible Steel Company of America, Harrison, N. J., and James D. Fleming, commissioner of industrial affairs, Troy, have been elected to the board of trustees along with the new president, vice-president and secretary.

Carl W. Bettcher has been elected vice-president of the Eastern Machine Screw Corporation, New Haven, Conn. Mr. Bettcher has been with the company for 17 years.

E. E. Griest, vice-president in charge of manufacture of the Franklin Steel Works, Franklin, Pa., has been elected vice-president and general manager of the Fort Pitt Malleable Iron Company, Pittsburgh, Pa. Mr. Griest was born in Zanesville, Ohio, and graduated from Purdue University in 1907. He served as a machinist apprentice, machinist and foreman in the Pennsylvania shops at Columbus, Ohio, from 1900 to 1904, and for a short time following graduation in 1907 was employed in the engineering department of the Crucible Steel Company of America. From 1907 to 1908, he was a machine shop foreman on the Erie and from 1908 to 1918 was assistant general foreman, assistant master mechanic and master mechanic, respectively, of the Pennsylvania at Ft. Wayne, Ind. In the latter year he became assistant general superintendent of the Chicago Railway Equipment Company and in 1919 was appointed general superintendent. From June 15, 1931, to February 15, 1936, he was vice-president in charge of manufacture of the Chicago Railway Equipment Company, the Grand Rapids Malleable Works, the Marion Malleable Iron Works and the Franklin Steel Works.

Obituary

J. E. Forsythe, inventor of the Forsythe draft gear and other devices for cars, died on March 7 at Chicago.

Joseph P. McNally, sales engineer for the past several years for the Iron & Steel Products, Inc., Chicago, died on February 29 at his home in Chicago. He was 68 years of age.

Personal Mention

General

Harry G. Miller, chief inspector of the Chicago, Milwaukee, St. Paul & Pacific, has been appointed engineer of tests at Milwaukee, Wis., to succeed A. G. Hoppe.

T. J. Clark, superintendent of motive power of the Great Northern at Spokane, Wash., has retired after 52 years of service with this company.

Alfred G. Hoppe, engineer of tests of the Chicago, Milwaukee, St. Paul & Pacific, has been appointed assistant mechanical engineer, with headquarters as before at Milwaukee, Wis.

T. M. Cannon, a draftsman in the mechanical engineer's office of the Chicago, Milwaukee, St. Paul & Pacific at Milwaukee, Wis., has been appointed chief inspector, with headquarters at Milwaukee, Wis., to succeed H. G. Miller.

Joseph B. Blackburn, who has been appointed engineer of motive power of the Advisory Mechanical committee of the Van Sweringen Lines, with headquarters at Cleveland, Ohio, was born on August 17, 1898, in Essex county, Va. After graduating from Virginia Polytechnic Institute in 1921 with a degree in mechanical engineering, Mr. Blackburn taught mechanical drawing in Norfolk, Va., for about three years. He entered railway service on May 1, 1924, as a draftsman in the mechanical department of the Chesapeake & Ohio at Richmond, Va., being appointed special mechanical inspector on February 1, 1929. After only a month in the latter position, Mr. Blackburn was appointed chief draftsman and a year later was advanced to mechanical engineer. On January 1, 1932, he was reappointed draftsman at Richmond and on August 1, 1933, became mechanical inspector. In March, 1934, he was appointed mechanical inspector on the Advisory Mechanical committee of the Van Sweringen Lines, and on December 1, 1934, was appointed to the position of equipment inspector on the staff of the mechanical vice-president of these lines, with headquarters at Huntington, W. Va.

Master Mechanics and Road Foremen

S. T. Kuhn, general enginehouse foreman of the New York Central at Collinwood, Ohio, has been appointed assistant master mechanic, with headquarters at Collinwood.

L. E. Allard has been appointed assistant master mechanic on the Kansas City Terminal division of the Missouri Pacific, with headquarters at Kansas City, Mo., succeeding R. H. Tait, retired.

Frank J. Regan, road foreman of engines on the Northern Pacific, has been appointed acting master mechanic of the St. Paul division, with headquarters at St. Paul, Minn., succeeding N. E. Entrikin, who has been granted a leave of absence.

Car Department

H. A. Sjogren has been appointed assistant to the superintendent of the car department of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Milwaukee, Wis.

Shop and Enginehouse

H. M. Gardner has been appointed enginehouse foreman of the Erie, with headquarters at Susquehanna, Pa.

J. L. Hughson has been appointed night general enginehouse foreman of the Erie, with headquarters at Hornell, N. Y.

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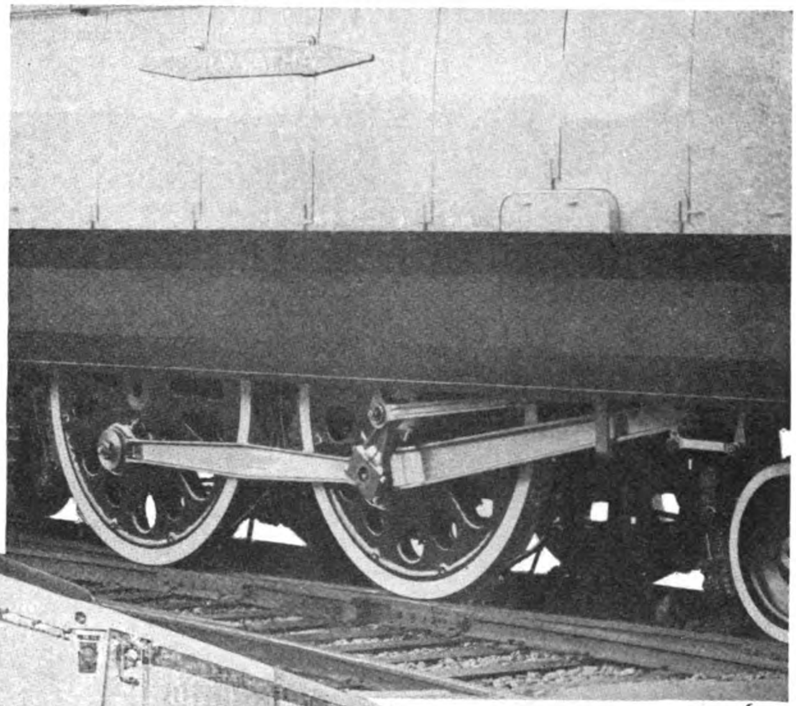
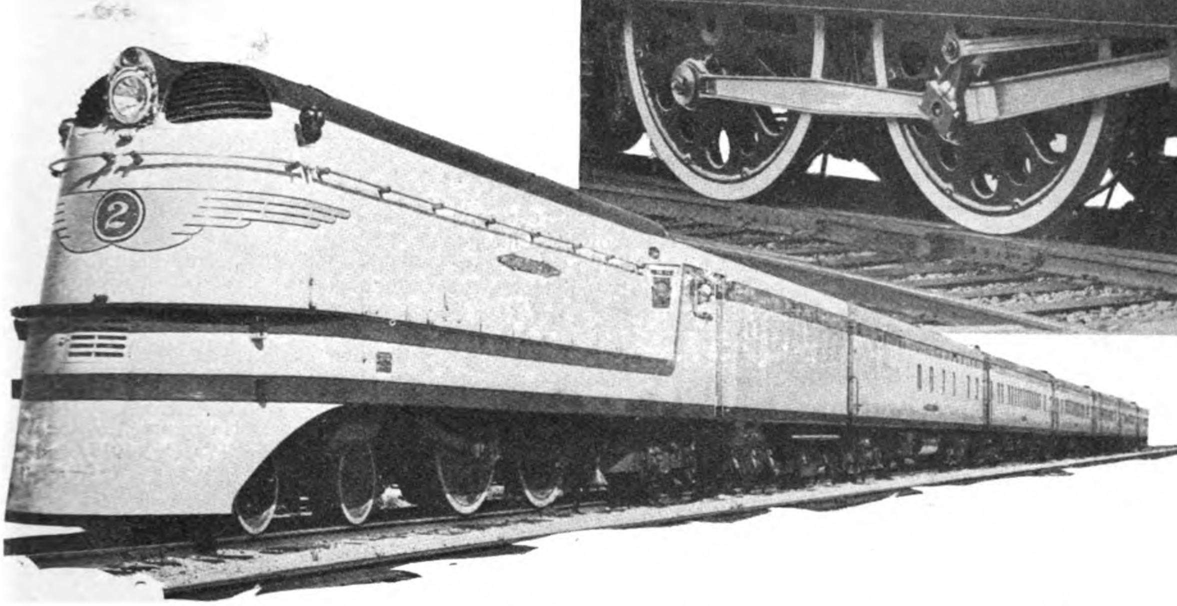
HIAWATHA'S SUPERB PERFORMANCE





Demonstrates the Economic Advantages of Alco Quality Forgings . . .

ALCO

TO go on making this 410-mile high speed run between Chicago, Milwaukee and St. Paul on a 6-hour, 30-minute schedule with sunrise certainty is a noteworthy performance.

It demonstrates unquestionably the absolute necessity for forgings of unusual structural stamina for it is their unfailing endurance which insures the continued serviceability of the entire locomotive unit in this high speed service.

ALCO materials are carefully selected and scrutinized — forging temperatures are scientifically correct — every detail of fabrication is under constant and precise control at all times.

ALCO main rods, side rods, crank pins, axles and other forged parts are on America's fastest locomotives. They are specified for safety — economy — and thorough dependability in every kind of heavy duty and high speed service.

To get ALCO quality, strength and performance you must specify ALCO Forgings.

AMERICAN LOCOMOTIVE COMPANY

ALCO FORGINGS

30 CHURCH STREET · NEW YORK · N·Y·

G. R. Seitz has been appointed general foreman of the back shop of the Erie at Hornell, N. Y.

John F. Murphy, assistant general foreman of the locomotive shops of the Boston & Albany at West Springfield, Mass., has been appointed superintendent of shops, succeeding John H. Minette, deceased. Mr. Murphy was born in 1880 at Springfield, Mass. He attended the public and evening

J. F. Murphy

trade schools, and on May 1, 1898, became a helper in the enginehouse of the Boston & Albany. In 1902 he was transferred to the shops and in 1908 was the first apprentice to serve his time on the Boston & Albany. He then became a machinist leader and in 1912 was promoted to the position of machine shop foreman. In 1928 he was appointed assistant general foreman of the locomotive shops, and since July of last year had been acting superintendent of shops. Mr. Murphy is one of the organizers of the Boston & Albany Supervisors' Club. He has always been an active supporter of apprentice training.

H. C. Dietrich has been appointed general foreman of the New York Central, with headquarters at Root street, Chicago.

C. A. Pease, assistant foreman at the enginehouse of the New York Central at East Buffalo, N. Y., has been promoted to the position of terminal foreman, with headquarters at Harmon, N. Y.

Obituary

Lambert N. Hopkins, who retired in 1928 as purchasing agent of the Chicago, Burlington & Quincy, died at his home at Santa Barbara, Calif., on March 17 at the age of 84 years.

J. H. Minette, superintendent of the locomotive shops of the Boston & Albany at West Springfield, Mass., died on February 29. Mr. Minette was born on March 3, 1872, at Danby, Vt. He attended Springfield evening schools; Burr & Burton seminary, Manchester, Vt., and took correspondence school courses. He served as a machinist apprentice at Manchester and in 1892 went to Springfield where he was employed by the Barney & Berry Skate Company in various departments for 10 years. He also worked as a machinist in the Knox and Stevens-Duryea automobile

J. H. Minette

plants. His service with the Boston & Albany began in 1904 as a machinist at the repair shops in West Springfield. He was appointed shop draftsman in 1914 and valuation engineer in 1915, the latter assignment carrying him to all parts of the Boston & Albany and the New York Central system. He returned to the West Springfield shops in July, 1918, and was assigned to special work. On April 1, 1919, he became assistant general foreman; on November 1, 1927, general foreman, and on January 1, 1929, superintendent of the locomotive shops.

MARINAC'S RAIL ODDITIES

Marinac has furnished us with the following explanations of the three cartoons which appear elsewhere in this issue:

Page 155. King of Hoboes! The whistle of a train is music to his ears—it's the call of the open road. For 23 years he has been King of the Hoboes' Union of America. He won his crown by election. All real hoboes join the union. To become a member they must agree to assist all runaway boys and induce them to return to their homes and parents. King Jeff Davis wants it understood that the term hobo does not mean bum. A bum never works, while hoboes are deserving but restless men who travel and work when they find work.

Page 164. Mr. Hodges, a veteran retired engineer, tells of an amusing but interesting event that occurred last summer. A sparrow built its nest on a coal car during one of its intervals of staying in the city. When the train went out the mother bird rode serenely upon her nest of eggs. Soon the five birds were hatched, but now the story was different. The mother bird was out early each morning obtaining food for her birds. When the train left the mother bird stayed at home, but when the train returned in the evening she had an assortment of grub-worms, angleworms and other insects piled up near the tracks, and in this manner gave her traveling family a good supper each evening. This program was carried on by the mother bird until her offspring could fly.

Page 174. People of Augusta, Ark., are proud of the Augusta Tramway & Transfer Company, which they claim is the shortest railroad in the country. With pride they point to the single mile of track which connects their community with the Missouri Pacific to the south, and to the somewhat antiquated locomotive that pulls cars loaded with cotton from their fields to the main line. But they are much prouder of 14-year-old Joyce Short, who, when she is not in school, sits in the cab of the 22-ton locomotive and handles the throttle with all the skill of a veteran engineer.

Engineer Short is no novice who runs the engine for a lark. She is a real railroad "man" and knows her "iron horse" from stem to stern. When this piece of rolling stock has to go into the roundhouse for attention she is on the job with wrench and oil can and does not have to be told what to do. Joyce came by her interest in railroading naturally. Her grandfather has been with the A. T. & T. going on 35 years. Her father, who died in 1922, also worked for the road.

John Short, her grandfather, hoped that he would have a grandson who could carry on the family tradition and he was a happy man when Joyce came to him and begged to be allowed to learn all there is to learn about running America's shortest railroad. At first he was skeptical, but he gave the girl a chance and she took to locomotives as a duck takes to water. For months she worked in the roundhouse and actually seemed to enjoy coming home at night covered with oil and soot. To the surprise of the men employed by the road, she revealed genuine mechanical ability and learned the construction of a locomotive as well as she did her lessons at school.

When her grandfather thought she knew enough about the engine to sit at the throttle, he took her in the cab with him and showed her all the tricks of driving an "iron horse" with a string of cars behind it. He showed her how to get the most out of the machine, how to ease it around curves and all the other tricks that engineers have to know to hold their jobs. Then he let the youngster demonstrate what she had learned. After a few runs up and down the mile track with her grandfather standing by, Joyce was allowed to pilot alone and she is now a full-fledged engineer.

The schoolgirl is a perfectly normal young woman with a flair for railroading. The builders of the little railroad would probably turn over in their graves if they could see a slender girl in her teens driving a locomotive over the tracks they laid 47 years ago. In those days the road carried passengers as well as freight, but the owners did not have enough money to buy an engine and the cars were pulled by mules. The one passenger coach was a second-hand trolley car which had seen service on the streets of St. Louis.

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RAILWAY
MECHANICAL ENGINEER

Designing for

High Tensile Steels

By H. M. Priest

This paper presents data to assist the designer in the correct utilization of these steels in light-weight rolling-stock construction

HIGH-TENSILE steels have made a notable contribution to the recent developments in light-weight railroad rolling stock which have captured the imagination of the public and stimulated the interest of engineers and manufacturers. The most obvious opportunities for economical and successful applications of such steels lie in the field of movable structures, such as passenger and freight cars, trucks, buses, street cars, mine cars and travelling cranes, but the products in many other fields are now being subjected to critical study in the endeavor to determine what possibilities for weight reduction are to be found there.

Any analysis of a specific problem should give attention to first cost, maintenance, depreciation and operating cost of the structure and in some cases to increased revenue from the additional "pay load" which may be permitted by the decrease in dead weight.

While these matters are important they can only be evaluated after a design has been prepared. This paper is concerned more particularly with this latter phase of the problem and aims to present some observations on designing for high-tensile steels which may be helpful to engineers in their investigations. Long experience with ordinary carbon steels of structural grade furnishes a natural background against which to make comparisons and to form judgments. Such comparisons will be facilitated by the arrangements of the text.

The working unit stresses are the principal factors in the design of any structure since they determine the sizes of the material, although the limitations imposed by such an item as a clearance diagram may modify the choice of the most economical sections. In order to make the paper of broad application, the formulae throughout the text have been kept in general symbols for which may be substituted the values of the unit stresses which pertain to the structure under consideration.

The design which serves as the basis for comparison will be referred to as the "basic design" in contrast with the designation "new design" which will be applied to the comparative design. The subscript *1* indicates a function or term for the basic design, while functions or terms for the new design are written with the subscript *2*. General formulae, applicable to all cases, are written without subscripts.

The selection of working unit stresses depends upon the class of structure to be designed and the character and magnitude of the loads to be carried. Most branches of engineering have adopted unit stresses for carbon steel which experience has shown will produce satisfactory structures. No attempt will me made to specify the unit stresses to be used with high-tensile steels when applied in particular fields of construction, but it is hoped that the succeeding discussion will prove definitely helpful to designing engineers.

It is quite generally the accepted viewpoint to regard the yield-point stress as indicating the useful strength of a structure. When this stress is reached the deformations increase rapidly accompanied by little or no increase in loads, permanent sets come into existence and the distorted structure may be said to have reached the end of its effectiveness. In other cases, the modulus of elasticity is often the controlling factor when a member will fail in buckling, either as a whole or locally in a portion of it.

Before entering upon the discussion of high-tensile steels it may be interesting to review the material and design specifications covering carbon steels of structural grade in three representative fields. Table I lists the physical requirements of the A. S. T. M. specifications for steel in bridges and buildings and those of the Association of American Railroads for structural steel. The brief abstracts of working unit stresses are from the design specifications of the American Railway Engineering Association, American Institute of Steel Construction and the Association of American Railroads and have been tabulated below the appropriate material specifications.

The factors of safety have been computed on the basis of the required minimum yield points. It will be noted that the material specifications for steel for bridges and buildings state that the yield point shall not be less than 33,000 lb. per sq. in. The A. A. R. specifications for structural steel set no such secondary minimum value for the yield point, but it does not appear reasonable to use one-half of 50,000, or 25,000 lb. per sq. in. as the minimum value when computing the factor of safety in car design. It is the experience of the mills that steel up to 3/4 in. in thickness will have a minimum yield point of 28,000 to 29,000 lb. per sq. in. when ordered to the A. A. R. specifications. Plates of around 1/4 in. in thickness will have a minimum yield point of about 33,000 lb. per sq. in. For the purpose of computing the factors of safety shown in Table I for the unit stresses of the A. A. R., the value of the minimum yield point has been taken as 29,000 lb. per sq. in. The seemingly higher factor of safety for compressive unit

stresses as compared to those for tension is due to the fact that the column formulae contain an allowance of 25 per cent for eccentricity, thus making the factor of safety equal to 2.20 divided by 1.25, or 1.76. This subject is treated more fully under the section dealing with compression.

A word of explanation may be desirable regarding the factors of safety for the shearing values. Tests have shown that the yield point in shear for steels of this grade is about 62.5 per cent of the tensile yield point. This factor has been used to obtain the results in the table.

Properties of High-Tensile Structural Steels

In the selection of a high-tensile steel there are several low-alloy steels from which to choose. Consideration should be given to a number of factors, the more important of which will be briefly discussed.

Tensile Strength—Steels suitable to a wide range of structure in which weight reduction is sought will have ultimate tensile strengths ranging up to about 100,000 lb. per sq. in.

Yield Point—The yield point is of prime importance for the reason that it is the strength upon which working unit stresses are generally based. The ratio of yield-point strength to ultimate strength in tension is about 0.50 to 0.60 for structural carbon steel. This ratio will increase for high-tensile steels, ranging up to 0.70 or 0.75. A narrow spread between yield point and ultimate strength is apt to be accompanied by a lowering of the ductility, for which reason it is probably well to limit the maximum yield point to about 75 per cent of the ultimate strength.

Ductility—It is often true that the ductility of steel decreases with increase of tensile strength. For steels above 100,000 lb. per sq. in. in tensile strength, the ductility might be reduced to a point where difficulties would be met in pressing and forming the steels. Even at strengths below this limit it has been found that the greater stiffness of these steels requires an increase in the radii of fillets for cold-pressing operations. A radius of two to three times the thickness of the material should give satisfactory results. Ductility is a property which enables the steel to yield at points of stress concentration and thus effect a redistribution of the stress without failure occurring locally.

Fatigue Strength—The fatigue strength or endurance limit becomes important when the structure, or parts of it, are subjected to varying or alternating stresses. Working unit stresses should then be based upon the fatigue strength or the yield point, whichever is the lesser of the two.

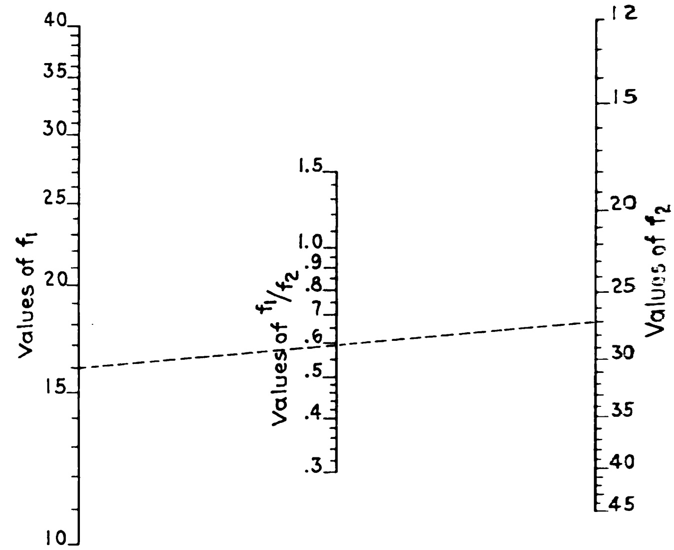


Fig. 1—Ratio of $\frac{f_1}{f_2}$

Impact Strength—Impact strength is usually determined from an Izod or Charpy test and is expressed as the number of foot-pounds of energy absorbed by a notched specimen when broken by the blow of a weighted pendulum. The test is supposed to indicate the resistance of the steel to shocks but there is no direct correlation with other properties of the steel. However, the tests have merit in comparing the relative impact strengths of the steel at various temperatures or after different heat treatments.

Corrosion Resistance—The use of high-tensile steel permits of reductions in the thicknesses of material and in some cases thereby introduces the question of the life of the thinner material under the action of corrosion. The body sheets of a hopper car are an excellent example of the problem of the effective life of the steel. In several recent developments of light-weight hopper cars a steel has been selected which has increased resistance to corrosion over that possessed by copper-bearing carbon steel.

Workability—Under this heading may be classed the performance of the steels in the various shop operations of cutting, punching, drilling, reaming, milling, planing, hot and cold pressing and flanging. These items are somewhat affected by the additional strength and stiffness of the high-tensile steels. As compared to shop practice with carbon steel of structural grade it will be found that the maximum thickness of material for

Table I—Specifications of Carbon Steels

Material specifications	A.S.T.M. A7—34 Bridges	A.S.T.M. A9—34 Buildings	A.A.R. M116—34 Structural
Tensile strength, lb. per sq. in.	60/72,000	60/72,000	50/65,000
Yield point, min.	0.5 T.S.	0.5 T.S.	0.5 T.S.
But not less than	33,000	33,000	......
Elong. in 8 in., min., per cent	$\frac{1{,}500{,}000}{T.S.}$	$\frac{1{,}400{,}000}{T.S.}$	$\frac{1{,}500{,}000}{T.S.}$
Elong. in 2 in., min., per cent	22	22	25
Design specifications	A.R.E.A. Railway Bridges, 1935	A.I.S.C. Buildings, 1934	A.A.R. Box Cars, 1929
Tension (net sec.), lb. per sq. in.	18,000	18,000	16,000
Tension (bending), lb. per sq. in.	18,000	18,000	16,000
Compression	Pin ends $\frac{P}{A} = 15{,}000 - \frac{1}{4}\left(\frac{L}{r}\right)^2$	$\frac{P}{A} = \frac{18{,}000}{1 + \frac{1}{18{,}000}\left(\frac{L}{r}\right)^2}$ max. = 15,000	Fixed ends $\frac{L}{r} \leq 40$ $\frac{P}{A} = 16{,}000$ Rankine formula: $S = \frac{P}{A}\left[1 + \frac{1}{25{,}000}\left(\frac{L}{r}\right)^2\right]$
Shear on webs, lb. per sq. in.	11,000	12,000	12,000
Factors of safety for	Min. Y.P. = 33,000	Min. Y.P. = 33,000	Min. Y.P. = 29,000
Tension	1.83	1.83	1.81
Compression $\left(\frac{L}{r} = 0\right)$	2.20*	2.20	1.81
Shear	1.87	1.72	1.51

* Includes 25 per cent for eccentricity.

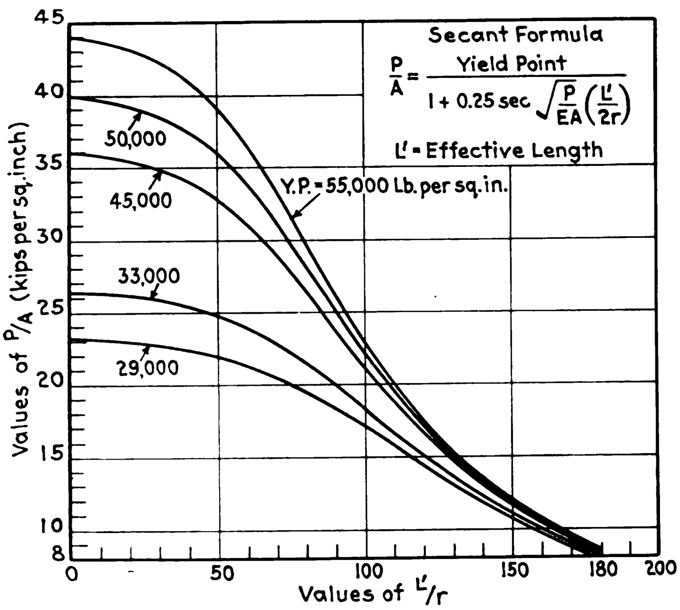


Fig. 2—Ultimate compressive stress

punching is somewhat less for high-tensile steel. The rate of speeds for drills and reamers may have to be reduced, perhaps by 25 per cent or 30 per cent. Hot pressing is practically the same as for carbon steel but in cold pressing operations it is necessary to use generous radii on all fillets. Due to the greater stiffness of a high-tensile steel it will be found desirable to decrease somewhat the speed of pressing in order to allow the steel sufficient time to adjust itself in the dies.

Weldability—The developments in the field of welding have opened up new possibilities in all lines of construction. Definite economies of weight may often be achieved by the application of welding to the fabrication. It is well to point out that the designer must change from the viewpoint of his past experience with riveted work if he is to make real progress with welding. In the light of present-day trends, it is essential that the high-tensile steels should have good welding qualities.

General Considerations—There are other properties which would be of special interest in particular fields of application, such as the coefficient of expansion, thermal conductivity, magnetic permeability, hardness and resistance to abrasion, but those given above are the principal ones. An extended discussion of each factor has not been attempted—simply an enumeration with brief comments. For more detailed information about high-tensile steels and their applications the reader is referred to a paper entitled "Modern Steels and Weight Reduction" by J. C. Whetzel, which was presented at the general meeting of the American Iron and Steel Institute on May 23, 1935.

For simplicity of treatment, the subject of design will be divided into sections, beginning with a discussion of "Tension." Clarity in the development of the subsequent topics requires the use of a factor of safety. The value selected in each case serves simply as an illustration and should not be taken as the writer's recommendation. As previously stated, the reader is expected to make his own selection to fit the particular problem under consideration.

Tension

The working unit stress for tension members is commonly based upon the yield point of the steel, using an appropriate factor of safety. By reference to Table I it will be seen that the grade of structural carbon steel which is specified by the Association of American Railroads has the following physical properties:

Tensile strength .... 50,000 to 65,000 lb. per sq. in.
Yield point .... ½ of tensile strength, min.

The working unit stress in tension for car construction is usually specified as 16,000 lb. per sq. in., which

Table II

Minimum yield point, lb. per sq. in.	Working unit stresses, lb. per sq. in. — Factor of safety = 1,813	In round numbers
29,000	16,000	16,000
33,000	18,200	18,000
45,000	24,810	25,000
50,000	27,600	27,000
55,000	30,340	30,000

gives a factor of safety equal to 29,000 divided by 16,000, or 1.813, when referred to the minimum yield point of 29,000 lb. per sq. in. previously proposed as a basis for the computations in Table I. The application of this factor of safety to several high-tensile steels will give the results shown in Table II.

The required cross-sectional area of a tension member is readily derived from the well-known formula:

$$A = \frac{P}{f} \qquad (1)$$

A = Required area, sq. in.
P = Total stress, lb.
f = Unit stress in tension, lb. per sq. in.

The relation between the areas required with different unit stresses will now be derived.

For the basic design:

$$A_1 f_1 = P$$

For the new design:

$$A_2 f_2 = P$$

From which

$$A_2 = \frac{f_1}{f_2} \times A_1 \qquad (2)$$

The nomograph in Fig. 1 solves graphically for the value of the ratio f_1/f_2. Let the basic unit stress, f_1, equal 16,000 lb. per sq. in. and the new stress, f_2, equal

Table III—Values of $\frac{f_1}{f_2}$

f_2, lb. per sq. in.	Values of f_1, lb. per sq. in. 12,000	16,000	18,000
16,000	.750	1.000	.....
18,000	.667	.889	1.000
20,000	.600	.800	.900
24,000	.500	.667	.750
25,000	.480	.640	.720
26,000	.462	.615	.692
27,000	.445	.593	.667
28,000	.429	.572	.643
29,000	.414	.552	.621
30,000	.400	.533	.600

27,000 lb. per sq. in. Lay a straight edge across the nomograph, connecting the point 16 for f_1 with the point 27 for f_2 as indicated by the dotted line. Where it crosses the middle vertical line, read the value of .59 for f_1/f_2. Then $A_2 = .59A_1$ which shows a saving of 41 per cent in area (hence in weight) when a steel is used which permits of a working unit stress of 27,000

Table IV—Angle Tension Members

(For total stress — 105,000 lb.)

Construction	Unit stress, lb. per sq. in.	Required area, sq. in.	Number—Size, in.	Net area, sq. in.	Gross area, sq. in.	Ratio
Riveted	16,000	6.56	2—6 x4 x⅜	6.56	7.22	1.00
	24,000	4.38	2—3½x3 x7/16	4.52	5.30	.73
	27,000	3.89	2—4 x3½x5/16	3.96	4.50	.62
	30,000	3.50	2—4 x3 x5/16	3.64	4.18	.58
Welded	16,000	6.56	2—5 x3 x7/16	...	6.62	1.00
	24,000	4.38	2—3 x2½x7/16	...	4.42	.67
	27,000	3.89	2—3½x3 x5/16	...	3.86	.58
	30,000	3.50	2—3½x2½x5/16	...	3.56	.54

Ratios in last column are those of gross areas to that for unit stress=16,000

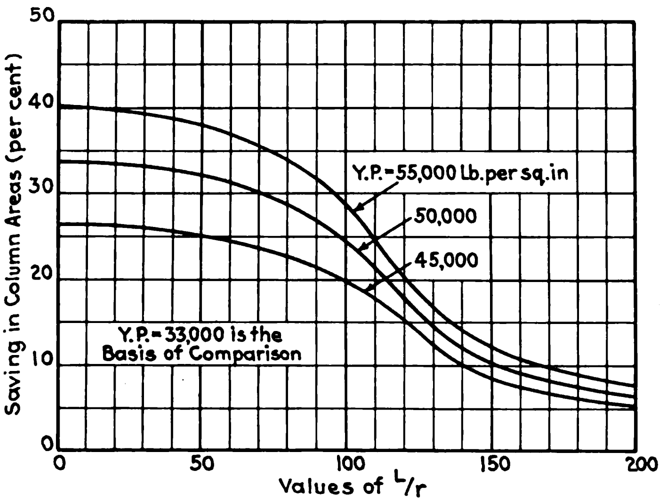


Fig. 3—Comparison of column areas

lb. per sq. in. Table III lists the values of the ratio for a few selected values of f_1 and f_2.

Table IV is a tabulation of the required sizes of angle tension members for several different unit stresses. Two methods of construction are given—one for riveted work in which the net section of the angles governs, the other for welded work when the full gross section of the angles is effective. Under the column headed "Ratio" are the ratios of the areas referred to that for a unit stress of 16,000 lb. per sq. in. Comparing these ratios to the theoretical values in Table III it will be seen that the full saving is not quite realized with riveted construction but is met with welded work. The table also brings out the weight saving that can be effected by welding.

Compression

In 1923 the American Society of Civil Engineers authorized a Special Committee on Steel Column Research. Engineers will find its first and second progress reports and final report[1] of invaluable assistance in the study of columns and compression members.

The following extracts are quoted from the "Summary and Conclusions" at the end of the final report:

1—Columns tested with hinged ends and eccentric loads give results both as to deflection and distribution of stress that agree very closely with the theoretical analysis within the limits of elasticity of the material.

2—The ultimate strength of such columns agrees fairly well with the theoretical strength based upon the yield point of the material and assuming elastic conditions up to the point of failure.

5—A rational column formula can best be constructed on the basis of the theoretical formula for eccentrically loaded columns, using values of eccentricity and free length of column derived from truss analysis. The yield point strength of the material may be used in a formula for ultimate strength. The formula representing ultimate strength will then be,

$$\frac{P}{A} = \frac{\text{Yield Point}}{1 + a \sec \sqrt{\frac{P}{AE}} \left[\frac{L'}{2r}\right]}$$

in which a = eccentric ratio to be used, and L' = free length of column.[2]

6—For columns bent in single curvature, an eccentric ratio of $a = 0.25$, to include both crookedness and eccentric application of load and a free length of three-fourths the full length for riveted connected members are suggested as reasonable values for ordinary trusses.

Fig. 2 gives the curves for ultimate strength of columns for several values of yield point, using the recommended eccentric ratio of 0.25. For riveted ends, such as occur in truss members, the effective length L' is to be taken as equal to 0.75 of the actual length L. Similarly for pin ended members, $L' = 0.85L$. It is quite evident from the chart that for the higher values of L'/r the values of P/A for all yield points approach equality, since the values approach the Euler load which is dependent upon the modulus of elasticity. This is due to the fact that the modulus of elasticity is practically the same for various grades of steel.

For the purpose of reducing the formula for ultimate strength to a working unit-stress basis a factor of safety of 1.80 will be used. The column formula then becomes:

$$\frac{P}{A} = \frac{\frac{\text{Yield Point}}{1.80}}{1 + 0.25 \sec \sqrt{\frac{1.80P}{AE}} \left[\frac{L'}{2r}\right]} \quad \text{.................} (3)$$

This so-called "secant formula" does not readily lend itself to rapid solution and the writer has derived the simpler formulae in Tables V and VI which do not deviate more than two per cent from the values given by Equation (3).

While these formulae are based on a factor of safety of 1.80 it is a simple matter to convert them to any other factor of safety by multiplying by 1.80 and dividing by the desired factor. For example, let it be required to derive a column formula for pin ends with a yield point of 33,000 lb. per sq. in. and a factor of safety of 1.76:

$$\text{For } \frac{L}{r} = 0 \text{ to } 140 \qquad \frac{P}{A} = \frac{1.80}{1.76}\left\{14{,}670 - .316\left(\frac{L}{r}\right)^2\right\}$$
$$= 15{,}000 - .323\left(\frac{L}{r}\right)^2$$

Table V—Column Formulae, Riveted Ends

Yield point, lb. per sq. in.	Limiting values of $\frac{L}{r}$	Working unit stress, lb. per sq. in.
55,000	0–120	$\frac{P}{A} = 24{,}500 - .690\left(\frac{L}{r}\right)^2$
	120–200	$\frac{P}{A} = \frac{24{,}500}{.52 + \frac{1}{12{,}390}\left(\frac{L}{r}\right)^2}$
50,000	0–130	$\frac{P}{A} = 22{,}200 - .563\left(\frac{L}{r}\right)^2$
	130–200	$\frac{P}{A} = \frac{22{,}200}{.52 + \frac{1}{13{,}740}\left(\frac{L}{r}\right)^2}$
45,000	0–140	$\frac{P}{A} = 20{,}000 - .454\left(\frac{L}{r}\right)^2$
	140–200	$\frac{P}{A} = \frac{20{,}000}{.52 + \frac{1}{15{,}300}\left(\frac{L}{r}\right)^2}$
33,000	0–160	$\frac{P}{A} = 14{,}670 - .246\left(\frac{L}{r}\right)^2$
	160–200	$\frac{P}{A} = \frac{14{,}670}{.52 + \frac{1}{20{,}780}\left(\frac{L}{r}\right)^2}$
29,000	0–165	$\frac{P}{A} = 12{,}900 - .192\left(\frac{L}{r}\right)^2$
	165–200	$\frac{P}{A} = \frac{12{,}900}{.52 + \frac{1}{23{,}450}\left(\frac{L}{r}\right)^2}$

Formulae are based on the "Secant" Formula.
Factor of Safety = 1.80.

[1] For first progress report, see A.S.C.E. Transactions, Vol. 89; for second progress report, see A.S.C.E. transactions, Vol. 95; for the final report, see A.S.C.E. Transactions, Vol. 98.

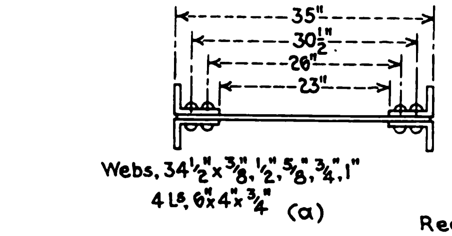
[2] The eccentric ratio a equals ec/r^2, in which e = the eccentricity of the load, c = distance from the neutral axis to the extreme fibre, and r = radius of gyration of the section. When there is a known eccentricity of loading, the ultimate strength of the column may be calculated by substituting the proper values in the expression for $a = ec/r^2$.

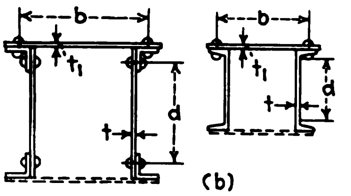
This is the factor of safety used by the American Railway Engineering Association in its Specifications for Steel Railway Bridges and results in the formula given in Table I, with which the above formula is seen to be in practical agreement.

$$\text{For } \frac{L}{r} = 140 \text{ to } 200 \qquad \frac{P}{A} = \frac{1.80}{1.76}\left[\frac{14670}{.52 + \frac{1}{16190}\left(\frac{L}{r}\right)^2}\right]$$

$$= \frac{15000}{.52 + \frac{1}{16190}\left(\frac{L}{r}\right)^2}$$

Following the procedure of comparing the results to be obtained by the use of high-tensile steels with those





Requirements Am. Ry. Eng. Assoc'n.

Yield Point	Max. Allow. Value Webs d/t	Covers b/t₁
33,000	32	40
45/50,000	28	36

Fig. 4—Unsupported plates in compression members

of ordinary carbon steel, the diagram of Fig. 3 gives the percentage in saving of column area, based upon the averages for pin and riveted ends, as derived from the formulae in Tables V and VI.

For example, at $L/r = 60$ the formulae give the following values of P/A for yield points of 33,000 and 55,000 lb. per sq. in.:

Yield point	Values of $\frac{P}{A}$, lb. per sq. in. Pin ends	Riveted ends	Average
33,000	13,530	13,780	13,655
55,000	21,330	22,020	21,675

For any given column load, P,

$$A_1 = \frac{P}{13,655} \text{ and } A_2 = \frac{P}{21,675}$$

Equating values of P:

$$A_2 = \frac{13,655}{21,675} A_1 = 0.631\ A_1$$

Hence the saving in area is 36.9 per cent, which is the value given by the diagram for the selected conditions of the example.

The individual strength of the component parts of a compression member should not be less than the strength of the member as a whole. Otherwise, premature failure may occur through local buckling. The thickness of material is reduced when high-tensile steels are used, thus creating a greater tendency for buckling unless provision is made against it.

The United States Bureau of Standards made an investigation of the buckling strength of column web plates[3]. The form of test specimen is shown in Figure 4(a). An error occurred in the report on page 753 in the formula for t^2 where Poisson's ratio should have been to the second power. O. E. Hovey prepared a discussion[4] of this report in which he corrected the formula and tables.

From this study the following formula for the ratio of the unsupported width to thickness was derived:

$$\frac{b}{t} = \sqrt{\frac{2.712E}{S_{cr}}} \qquad (4)$$

in which b = unsupported width of plate.
t = thickness of plate.
S_{cr} = critical buckling unit stress.
E = modulus of elasticity.

When we let S_{cr} equal the yield point we obtain the following values of b/t with $E = 29,000,000$ lb. per sq. in.:

Yield Point. lb. per sq. in.	$\frac{b}{t}$
29000	52.1
30000	51.2
33000	48.8
35000	47.4
40000	44.3
45000	41.8
50000	39.7
55000	37.8

The American Railway Engineering Association Specifications for Steel Railway Bridges have the following requirements for the webs and covers of compression members:

Yield point, lb. per sq. in.	Max. values of $\frac{\text{Width}}{\text{Thickness}}$ Webs	Covers
33,000	32	40
45/50000	28	36

Fig. 4(b) illustrates these limiting conditions and it will be seen that these limitations are conservative when compared to the values based upon the tests of the Bureau of Standards.

Table VI—Column Formulae, Pin Ends

Yield point, lb. per sq. in.	Limiting values of $\frac{L}{r}$	Working unit stress, lb. per sq. in.
55,000	0–110	$\frac{P}{A} = 24,500 - .880\left(\frac{L}{r}\right)^2$
	110–200	$\frac{P}{A} = \frac{24,500}{.52 + \frac{1}{9,690}\left(\frac{L}{r}\right)^2}$
50,000	0–115	$\frac{P}{A} = 22,200 - .725\left(\frac{L}{r}\right)^2$
	115–200	$\frac{P}{A} = \frac{22,200}{.52 + \frac{1}{10,660}\left(\frac{L}{r}\right)^2}$
45,000	0–125	$\frac{P}{A} = 20,000 - .583\left(\frac{L}{r}\right)^2$
	125–200	$\frac{P}{A} = \frac{20,000}{.52 + \frac{1}{11,870}\left(\frac{L}{r}\right)^2}$
33,000	0–140	$\frac{P}{A} = 14,670 - .316\left(\frac{L}{r}\right)^2$
	140–200	$\frac{P}{A} = \frac{14,670}{.52 + \frac{1}{16,190}\left(\frac{L}{r}\right)^2}$
29,000	0–145	$\frac{P}{A} = 12,900 - .247\left(\frac{L}{r}\right)^2$
	145–200	$\frac{P}{A} = \frac{12,900}{.52 + \frac{1}{18,220}\left(\frac{L}{r}\right)^2}$

Formulae are based on the "Secant" Formula.
Factor of safety = 1.80.

[3] Reported in Bureau of Standards Technicological Paper No. 327, entitled "Compressive Strength of Column Web Plates and Wide Web Columns."

[4] Bulletin 374 of the American Railway Engineering Association, February, 1935.

(To be concluded next month)

Six Year Summary of Air Conditioned Cars

Table I—By Types of Cars

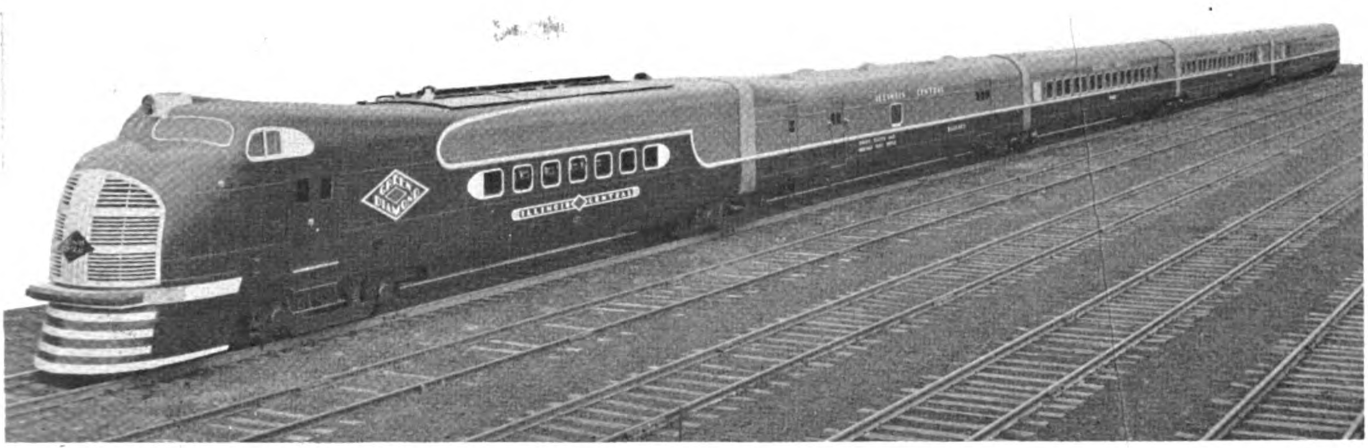
Name of railroad	Total cars: 1933 (Note A)	1934	1935	As of Dec. 31, 1935	Coaches (Note B)	Combination (Note C)	Dining (Note D)	Lounge diners (Note E)	Chair	Observation (Note F)	Sleeping Cars (Note G)	Business
Alton	16	2	7	25	4	4	4	5	6	2	..	..
A. T. & S. F.	23	36	77	136	8	..	41	7	62	18	..	..
A. C. L.	..	7	15	22	15	..	7	..	..	..	..	..
B. & O.	62	59	72	193	93	32	39	15	4	8	..	2
B. & M.	1	10	13	24	18	2	4	..	..	..	..	..
Cen. of Ga.	..	..	4	4	2	..	..	2	..	..	..	..
C. & O.	12	6	19	37	22	..	5	5	..	..	..	4
C. & E. I.	2	4	4	10	2	2	4	2	..	..	..	..
C. M. St. P. & P.	..	22	68	90	38	..	19	7	10	2	14	..
C. B. & Q.	..	25	64	89	25	..	19	7	33	5	..	..
C. & N. W.	5	17	70	92	48	10	15	3	9	7	..	..
C. St. P. M. & O.	..	..	13	13	4	..	5	4	..	..	..	..
C. R. I. & P.	4	17	27	48	..	4	15	10	15	4	..	..
D. & H.	..	..	1	1	..	..	..	1	..	..	..	..
D. L. & W.	..	9	12	21	10	..	6	3	..	1	..	1
D. & R. G. W.	..	12	20	32	16	..	5	4	..	7	..	..
Erie	..	20	1	21	15	..	2	2	..	..	..	2
Fla. E. C.	..	..	11	11	8	..	3	..	..	..	..	..
Ft. W. & D. C.	..	..	14	14	10	..	4	..	..	..	..	..
Grt. Nor.	..	13	16	29	12	..	16	..	..	..	..	1
G. M. & N.	..	..	5	5	1	..	..	2	..	..	2	..
Ill. Cen.	11	..	44	55	2	9	20	14	7	2	..	1
Lehigh Valley	..	2	12	14	4	..	5	2	3	..	..	..
L. & N.	..	8	5	13	..	..	13	..	..	..	..	..
Me. Central	..	7	..	7	5	2	..	..	..	..	..	..
M-K-T	8	4	5	17	..	..	9	..	3	4	..	1
Mo. Pac.	12	26	111	149	58	8	12	38	24	5	..	4
N. C. & St. L.	..	5	..	5	..	..	2	3	..	..	..	..
N. Y. C. System	15	73	58	146	78	..	68	..	..	..	..	..
N. Y. C. & St. L.	..	1	3	4	3	..	..	..	..	..	..	1
N. Y. N. H. & H.	11	56	146	213	167	15	26	..	2	3	..	..
Nor. & West.	..	7	34	41	22	8	11	..	..	..	..	..
Nor. Pacific	..	19	26	45	16	..	15	..	..	14	..	..
Pennsylvania	160	116	93	369	194	72	100	3	..	..	..	..
Pullman Co.	244	1161	1828	3233	..	..	..	..	353	494	2386	..
Reading	..	9	21	30	17	7	6	..	..	..	..	..
C. R. R. of N. J.	..	..	13	13	10	..	3	..	..	..	..	..
R. F. & P.	..	7	10	17	10	2	4	1	..	..	..	..
St. L.-S. F.	17	12	40	69	26	2	11	7	14	5	2	2
Seaboard A. L.	..	26	33	59	23	13	16	6	..	..	..	1
Southern	..	..	27	27	..	..	27	..	..	..	..	..
Sou. Pacific	14	18	106	138	35	..	45	4	39	15	..	..
Tex. & Pac.	7	..	44	51	34	..	9	..	4	3	..	1
Union Pac.	18	38	131	187	63	..	51	..	38	35	..	..
Wabash	6	14	20	40	..	..	..	11	29	..	..	..
Western Pacific	..	4	4	8	4	..	4	..	..	..	..	..
	648	1872	3347	5867	1122	192	670	168	655	634	2404	22

Note A—Includes cars air-conditioned prior to and including 1933.
Note B—Includes coach-club and coach-lounge cars.
Note C—Includes passenger-mail, passenger-baggage and club-baggage cars.
Note D—Includes cafe cars.
Note E—Includes cafe-club, cafe-parlor, cafe-lounge, cafe-coach and buffet-lounge.
Note F—Includes observation-chair, observation-lounge, and club cars.
Note G—Includes sleeper-chair, tourist-sleepers and sleeper-observation cars.

Table II—By Types of Systems and Refrigerants Used

Name of railroad	Total No. of cars	Type of system: Electro-mech.	Direct mech.	Ice	Steam ejector	Refrigerant used: Freon	Water	Ice	Other refrigerants
Alton	25	25	..	..	..	24	..	..	1*
A. T. & S. F.	136	1	..	..	135	..	135	..	1*
A. C. L.	22	3	..	..	19	3	19	..	..
B. & O.	193	193	..	..	..	193	..	..	..
B. & M.	24	13	..	11	..	13	..	11	..
Cen. of Ga.	4	..	..	..	4	..	4	..	..
C. & O.	37	..	37	..	..	37	..	..	..
C. & E. I.	10	..	..	4	6	..	6	4	..
C. M. St. P. & P.	90	..	..	..	90	..	90	..	..
C. B. & Q.	89	51	4	34	..	55	..	34	..
C. & N. W.	92	14	5	73	..	5	..	73	14†
C. St. P. M. & O.	13	..	..	13	..	..	..	13	..
C. R. I. & P.	48	..	..	36	12	..	12	36	..
D. & H.	1	..	..	1	..	..	..	1	..
D. L. & W.	21	..	..	11	..	10	..	11	..
D. & R. G. W.	32	..	10	32	..	..	..	32	..
Erie	21	..	..	..	21	..	21	..	..
Fla. E. C.	11	..	..	..	11	..	11	..	..
Ft. W. & D. C.	14	14	..	..	..	14	..	..	..
Grt. Nor.	29	..	..	29	..	..	..	29	..
G. M. & N.	5	5	..	..	..	5	..	..	..
Ill. Cen.	55	11	34	10	..	45	..	10	..
Lehigh Valley	14	14	..	..	..	14	..	..	..
L. & N.	13	..	..	..	13	..	13	..	..
Me. Central	7	..	..	7	..	..	..	7	..
M-K-T	17	6	..	3	8	3	8	3	3*
Mo. Pac.	149	21	..	97	31	20	31	97	1†
N. C. & St. L.	5	..	..	..	5	..	5	..	..
N. Y. C. System	146	73	58	15	..	131	..	15	..
N. Y. C. & St. L.	4	..	4	..	..	4	..	..	..
N. Y. N. H. & H.	213	132	..	81	..	132	..	81	..
Nor. & Wes.	41	37	..	..	4	37	4	..	..
Nor. Pac.	45	..	45	..	..	45	..	..	..
Pennsylvania	369	66	..	302	1	65	1	302	1†
Pullman Co.	3233	126	1795	1000	312	1921	312	1000	..
Reading	30	30	..	..	..	30	..	..	..
C. R. R. of N. J.	13	13	..	..	..	13	..	..	..
R. F. & P.	17	10	5	..	2	15	2	..	..
St. L.-S. F.	69	..	..	69	..	..	..	69	..
Seaboard A. L.	59	1	58	..	..	59	..	..	..
Southern	27	..	..	..	27	..	27	..	..
Sou. Pac.	138	..	19	111	8	19	8	111	..
Tex. & Pac.	51	1	1	20	29	2	29	20	..
Union Pac.	187	15	144	..	28	159	28	..	..
Wabash	40	1	..	39	..	1	..	39	..
Western Pac.	8	..	..	..	8	..	8	..	..
	5867	876	2219	1998	774	3074	774	1998	21

* Ammonia. † Methyl-chloride.



Illinois Central Receives

The Green Diamond

Five-car articulated train, powered with 1,200-hp. Diesel engine, weighs 476,800 lb., seats 144 persons and cost $425,000.

THE Green Diamond, a five-car, articulated, Diesel-electric train which was delivered recently to the Illinois Central, is now on an extensive exhibition tour of about 50 cities in the Mississippi Valley, the Southwest and the Great Lakes Region. About six weeks will be required to make the 4,000-mile exhibition tour on Illinois Central rails and the 3,500-mile off-line tour which are planned. The exhibition tours will be completed in time to place the train in regular Chicago-St. Louis service on May 17. Sustained speeds well in excess of present schedules will permit this train to make a round trip daily, supplanting two steam trains now required for comparable service.

The new Illinois Central train, designed by the Pullman-Standard Car Manufacturing Company, was built at the Pullman Car Works at a cost of approximately $425,000. It consists of five streamline articulated car bodies embodying, primarily, riveted Cor-Ten steel construction. Aluminum is extensively used for interior finish and decorative features.

The train, with a total seating capacity for 120 passengers, plus 24 seats at dining tables, is air conditioned throughout and provided with modern dining-car facilities. It operates on six roller-bearing trucks, and has a light weight of 476,800 lb., or about 50 per cent of the weight of an equivalent steam train. It is driven by an Electro-Motive 1,200-hp. power plant, with electric generator and motors furnished by the General Electric Company. It is expected that the train will make about 1.5 miles per gal. of fuel oil and 35 miles per gal. of engine lubricating oil. Water consumption for both engine cooling and train heating will depend largely upon outside temperatures, and in a recent test was 700 gal. for a one-way trip of 293 miles.

The overall length of the train is 328 ft. 6 in. and the five body units having general arrangements, dimensions and seating capacities as shown in the drawings, include a power unit, a mail-baggage unit, two chair units and a diner observation unit. Each of the three passenger-carrying bodies has a side entrance door on each side, and the diner-observation unit is provided with an emergency end door.

The exterior of the train is smartly styled. Two shades of green are used for the exterior colors with striping lines of silver and scarlet between the two greens. Lettering of silver aluminum and scarlet is carried out in a modern style. The name of the train, Green Diamond, is worked out in a diamond design with letters of silver and scarlet and applied to both sides of the power unit.

A cast aluminum name plate with the words "Illinois Central" in highly polished letters, separated by a green diamond outlined in silver, is also applied on each side of the power unit, under the windows.

General Construction

The underframe assembly in each of the Green Dia-

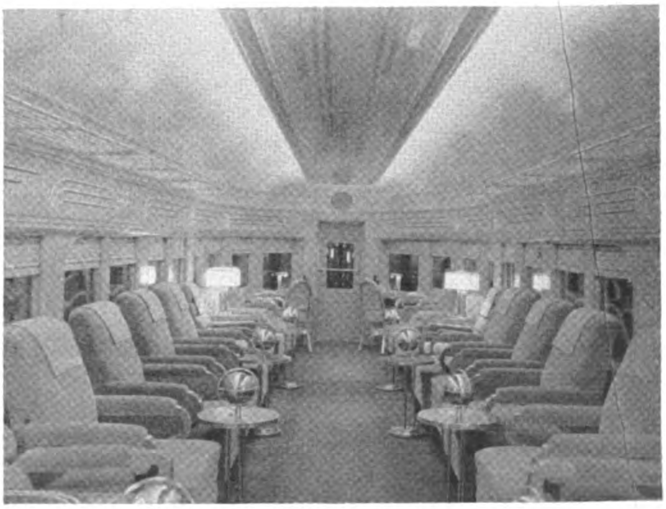
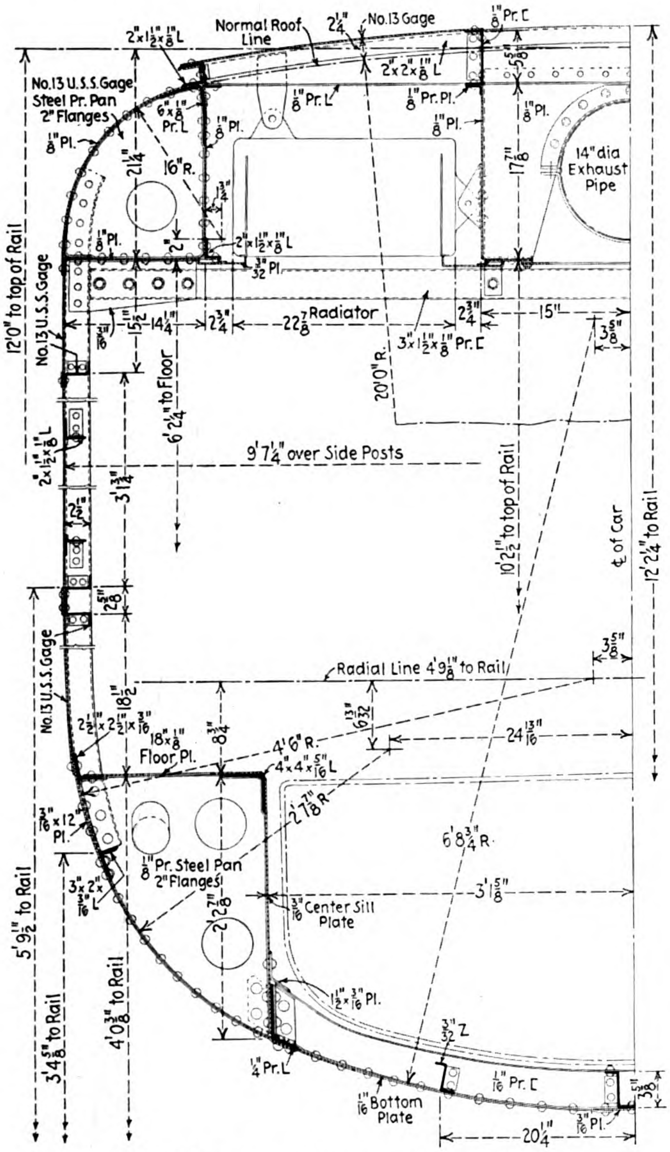


Table lamps supplement indirect lighting in the observation-lounge

mond bodies is a combination of riveting and spot welding. The center sills are of web and cover plates with rolled chord angles. The floor beams are of pressed-steel shapes. The bottom sheet stiffeners and struts between these stiffeners and the floor beams are of drawn or pressed shapes, as are the longitudinal floor stringers.

The bottoms of the car bodies are completely enclosed, brake equipment, reservoirs, tanks, piping, etc., being located in the space between the floor and bottom sheets, accessible through removable floor doors.

The side-sill construction is a combination of drawn

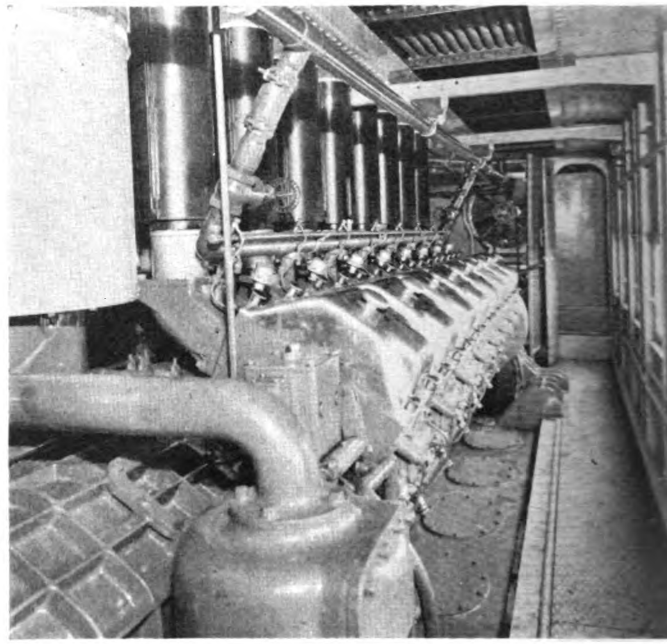


Half section of a passenger-carrying body unit

members and rolled plates, attached to the car bodies by rivets and welding. Side posts are of pressings; where box sections are used, these are formed by welding after these posts were set in place.

Carlines and purlines are of pressed shapes. Roof sheets are riveted. End frames at articulated ends are a combination of riveted and welded construction. End sills are of entirely welded construction, riveted to the framing members. Diagonal braces are used at the ends to tie the shoulder construction to the end sills, connections on end sills being adjacent to the door posts.

While the five articulated Cor-Ten steel body units of this train embody primarily riveted construction, a sub-



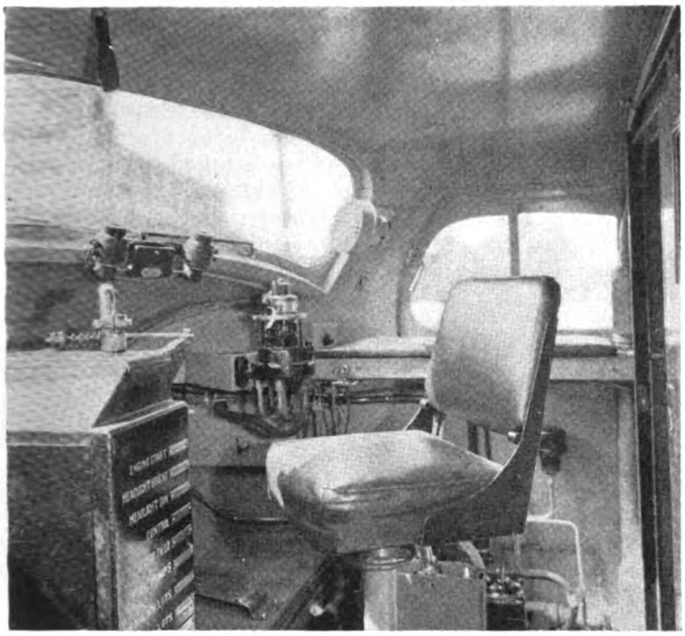
The engine room

stantial amount of electric welding was used in fabricating the underframes and superstructure frames. There is approximately 6,800 lineal feet of arc welding in the train in addition to which about 5,100 spots (machine spot-welds) were used for side-sill reinforcing sub-assemblies.

In the power car approximately 2,200 lineal feet of arc welding was performed on the underframe, front-end assembly, rear-end framing, side and roof framing and removable roof. The body-bolster sub-assembly was built up and welded in jig welds for application to the car.

In the trailing cars some 4,500 lineal feet of arc welding was done. This included many points in the underframe; side and roof framing; end framing and car ends; front ends and rear end framing; post construction and side-plate covers. In addition to these major jobs much miscellaneous arc welding was done on parts such as conduits, door frames, step welds, air-conditioning equip-

The seats have individual reclining backs

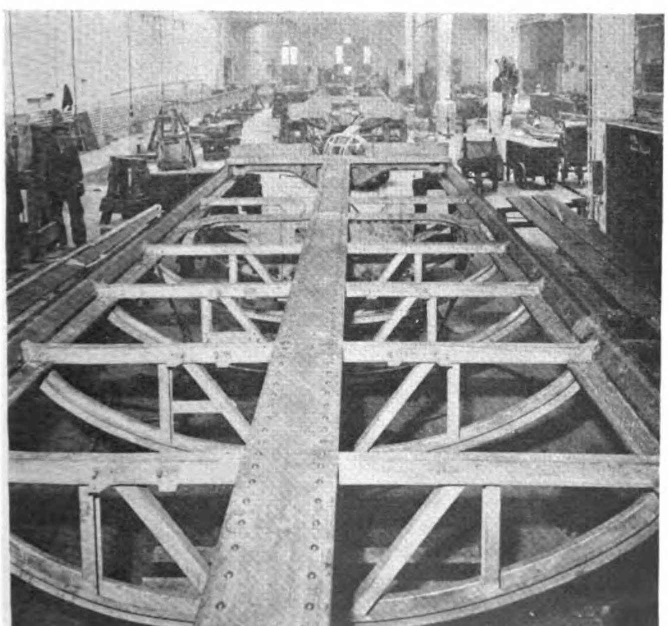


The operator's control station

ment, motor base supports and framing, and fresh air intakes.

The streamline rounded front end of the power car is of built-up angles and plates to form an anti-telescoping construction. The rear end of the train is also of streamline design, provided with observation end sash and emergency door.

The body articulation eliminates the use of couplers, draft gears and the vestibule mechanism, such as commonly used in the conventional types of passenger-carrying cars. The articulated feature also reduces the number of trucks to service and maintain to six instead of ten, as would be required for a similar train of separate cars. The gaps between the units are entirely closed at sides and roofs by means of diaphragms made of extra-stretch pigmented sheet rubber, spanning from one body to the next. The passageways between the bodies are also enclosed and dust tight, inner diaphragms being used. These also are made of extra-stretch rubber. A



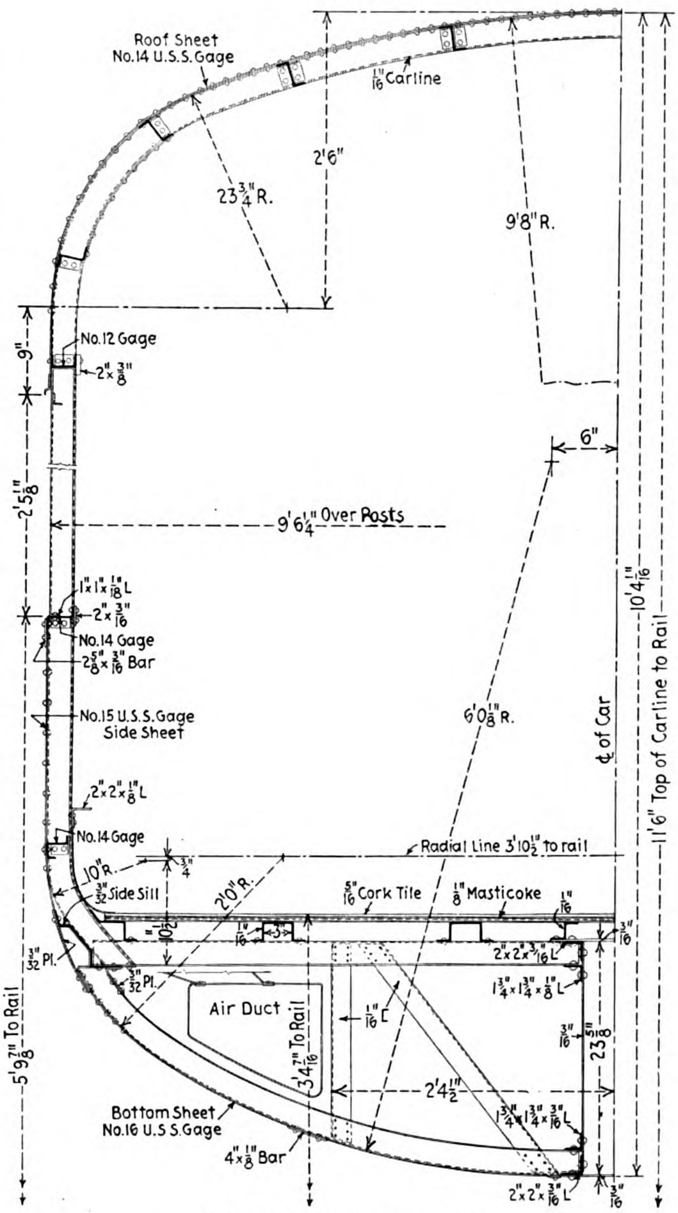
The underframe during construction

drawbar, for emergency use at either the front or the rear end of train is carried on the train.

Interior Decoration

The interior finish and head linings in the passenger cars are of aluminum alloy, the wainscoting being of pressed composition board.

In the passenger compartments horizontal moldings with satin-finish aluminum faces run in unbroken lines from one end of each compartment to the other above and below the windows. The forward ends of each double window are given speed-line curves and further



Half section of the power unit

accentuated by polished aluminum moldings. Three decorative satin-finish aluminum moldings repeating the speed-line curve of the window are used on the frieze panels over each double window.

The two chair cars are handled decoratively as a unit, with blue-grey walls, ivory ceilings and darker blue wainscotings. Floors in the chair compartments are covered with cork tiles finished in natural shades. Carpet of deep raisin tones is used for an aisle strip in the chair compartment.

The unusually comfortable seats are of the three-

position, reclining-type with satin-finish aluminum pedestals and fittings. A two-tone line-pattern of acorn-colored mohair, with the lines running transversely, is used for seat covering.

The window shades are silk-faced with horizontal lines in raisin and acorn colors on a tan background, recalling the color of the carpet and seat covering. The basket racks are enameled to match the ceiling.

Removable card tables and tables for the dining section in the chair cars are of a black formica with inlaid tops and edges of satin-finish aluminum.

The diner-observation car has the same design of finish as used in the chair cars, but is distinctive because of colorings and furnishings. The walls are finished in sea green with ivory ceilings and darker green wainscotings.

The dining section at the forward end of the observation room has aluminum frame chairs in satin finish, upholstered in a gold-colored, horizontal-line pattern mohair. The dining tables are black formica with two inlaid aluminum lines in the top, and with three satin-finish aluminum lines inlaid on the edges.

Lounge chairs are of three types, of a special design, having a special bleached walnut finish on the exposed wood portions. Three types of seat coverings are used; one, a green modern design to tone with the green walls; another of raisin color similar to the carpet; and the last, a key fabric of tan, green and raisin, to tie all the colors together.

Kitchen Equipment and Other Details

The kitchen is provided with an oil-burning range, broiler, warming ovens, urn and steam table. Polished stainless steel is used for table tops, sinks, chipped ice wells, facings of refrigerators, range, work tables and lower lockers. The interior linings of cold boxes, refrigerator compartments, racks, etc., are also of stainless steel.

Dry-ice refrigeration, automatically controlled, is used in the large refrigerators, cold boxes and ice-cream cabinet. The kitchen is provided with a serving bay to facilitate serving meals, which is open on three sides.

All exterior side doors are of steel construction; all end doors and interior doors are of aluminum construction. Passenger side entrance doors are of the hinged type, swinging inwardly. Baggage and mail compartment side doors slide on curved upper guides and lower tracks, designed to bring the doors flush with the sides of the train when closed. Main end doors and toilet-room doors in passenger-carrying bodies are provided with an anti-pinch feature.

Forged steps of designs to suit streamline conditions are provided for the cab and engine compartment, mail room and baggage compartment. The passenger entrance steps are of the pivoted type, operated with sprocket and chain mechanism so designed that the door risers and tread form a part of the platform and door threshold, and the back of the step lines up with the contour of the car shell and entirely closes the step opening when in raised position.

Truck and Power-Plant Details

The trucks throughout the train are of four-wheel type, with Commonwealth frames of cast steel. The trucks supporting the traction motors, that is, the two forward trucks, have wheel bases of 8 ft. 4 in.; the remaining four trucks have 9 ft. wheel bases.

The wheels are of rolled steel, those on the motor trucks are 36 in. in diameter with 1 in. in 20 in. taper treads; the balance of the wheels are 33 in. in diameter with cylindrical treads. Timken outside-type roller bearings are provided on the axles of the two motor trucks. The remaining trucks have American Steel Foundries roller-bearing wheel and axle units with Timken bearings.

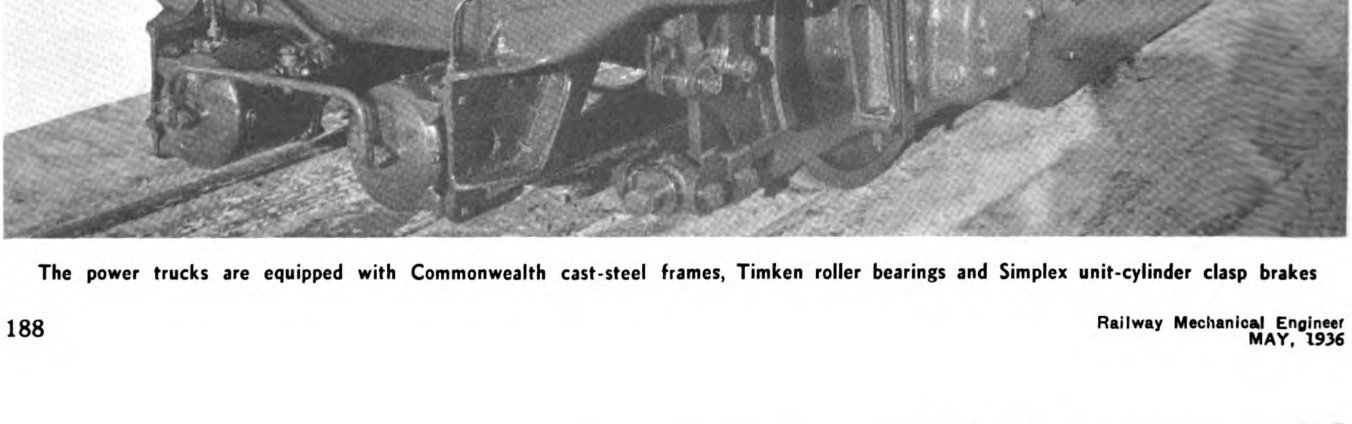
All trucks have Simplex clasp brakes and unit truck-mounted air-brake cylinders, one per wheel. Four brake shoes are used in two brake heads for each wheel. Points of contact between brake levers and truck frames are covered with fibre pads to dampen vibration and noise.

Manganese steel liners are used in the bottom of the first motor-truck center plate and between the body and truck center plate on the rear truck. All articulated center plates have manganese steel liners at all wearing surfaces.

All trucks at articulations and the rear truck have a double swing-motion, using auxiliary bolsters and spring planks and providing additional coil springs under the auxiliary bolster for easy riding.

The power-plant equipment in this train was designed and supplied by the Electro-Motive Corporation. The apparatus consists essentially of a two-cycle engine, engine control equipment, engine cooling system, engine exhaust system, engine lubricating system, electric transmission, transmission control apparatus, storage battery and charging equipment, auxiliary oil engine, auxiliary a.c. generator and mechanically driven air compressor.

The main engine is a V-type, 16-cylinder, high-com-

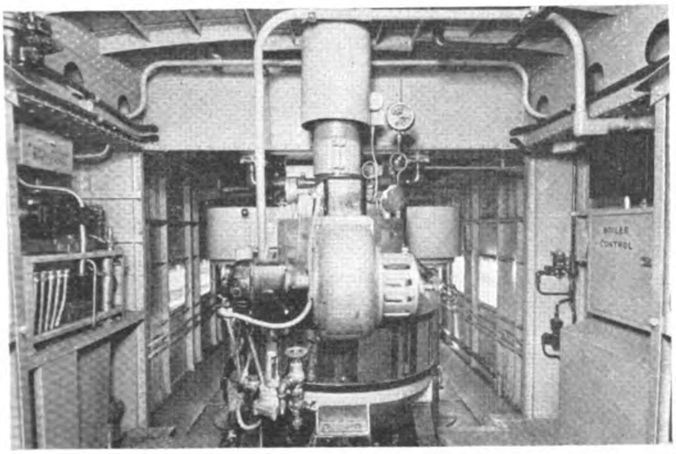


The power trucks are equipped with Commonwealth cast-steel frames, Timken roller bearings and Simplex unit-cylinder clasp brakes

pression, two-cycle oil engine of 8-in. bore and 10-in. stroke, developing 1,200 hp. at 750 r.p.m. Power for all auxiliaries driven by the main engine, directly or indirectly, is in excess of its rating.

The cylinder block and crankcase have been combined into one unit of welded steel construction. The engine base of this power plant is of unique design, incorporating in a single welded steel assembly a sub-base for mounting the coupled engine and generator and a fuel supply tank.

The power produced by the prime mover is delivered to the driving wheels through an electrical transmission consisting of General Electric generator, traction motors



High-pressure, oil-fired heating boiler

and PCL control apparatus. This equipment is supplemented by a storage battery and an auxiliary battery-charging generator.

The generator is designed to provide a characteristic most suitable for this particular engine. There are four 300-hp. motors, carried on the first and second trucks.

Weights of Car Bodies and Trucks in Illinois Central High-Speed Train

Light Weights			Light Weights of Body Units	
On No. 1 truck	73,320 lb.		Power	115,800 lb.
On No. 2 truck	65,100 lb.		Mail and baggage..	44,100 lb.
On No. 3 truck	46,070 lb.		Chair	52,210 lb.
On No. 4 truck	53,020 lb.		Chair	55,400 lb.
On No. 5 truck	62,290 lb.		Diner-lounge	69,040 lb.
On No. 6 truck	36,750 lb.			
On all trucks	336,550 lb.	336,550 lb.		336,550 lb.
Of No. 1 truck	32,680 lb.			
Of No. 2 truck	33,000 lb.			
Of No. 3 truck	18,790 lb.			
Of No. 4 truck	18,800 lb.			
Of No. 5 truck	18,850 lb.			
Of No. 6 truck	18,130 lb.			
Of all trucks	140,250 lb.	140,250 lb.		140,250 lb.
Light weight of train.....		476,800 lb.		476,800 lb.

They are of the self-ventilated, heavy-duty railway type. Clean air is supplied to the motors from inside the car body through flexible air ducts supported between the motor and the car underframe.

A 32-cell battery is furnished to supply power for engine starting, transmission control, cab and engine-room lights and emergency train lights. It has a capacity of 450 amp. hr. at the 10-hr. discharge rate.

The power-plant equipment includes a small 110-hp. oil-electric power plant which is provided to supply auxiliary power for the battery-charging and the train-line auxiliaries. This auxiliary unit consists of a four-cycle high-compression oil engine rigidly coupled to a 60-kw., 220-volt, 3-phase, a.c. generator. The driving engine is similar in design to the main engine and develops its rating at 1,200 r.p.m.

Mounted on the auxiliary generator end frame is a 7-kw., 76-volt, d.c. exciter which, in addition to its function of providing excitation for the generator, is used for battery charging. The a.c. power supply will furnish power for the train-line equipment, such as air-conditioning, radio, lighting, kitchen blower, steam-heating control and electric appliances in the kitchen.

The air compressor is a two-stage, water-cooled unit, equipped with inter-cooler between the low- and high-pressure pistons. It is mechanically driven from the main engine and has a displacement of 79.4 cu. ft. per min. at 750 r.p.m.

Heating, Air Conditioning and Brake Equipment

The train is heated by a Vapor, 800-lb.-per-hr., high-pressure, oil-fired steam boiler, burning the same fuel oil as that used in the main Diesel engine. Fin tubing and piping of copper are used in connection with the reduced pressure heating system. The steam train line and other piping under live steam pressure is of steel pipe. Flexible-armored hose connections are used between the body units.

The chair-car bodies and the diner-observation unit also have preheated air admitted through grilled duct openings in the side walls at floor level, this air operating in conjunction with the air-conditioning system.

Both of the chair cars and the diner-observation car are provided with Frigidaire air conditioning equipment.

Brake equipment for the Green Diamond consists of the Type H.S.C. light-weight design with Decelakron electro-pneumatic control, furnished by the New York Air Brake Company. Copper tubing and copper fittings are used throughout except on the trucks and pipes extending outside of the bottoms of body units, which are of heavy steel pipe.

General Lighting System, Signal, Etc,

Indirect lighting from a central duct, forming an architectural part of the cars, is used in the chair cars. There are 200 lights in two troughs, these lights being rated at 15 watts. The lighting circuits operate at 110 volts. Similar indirect lighting, with 185 lights in two center ceiling troughs, is provided in the diner-observation car. Recessed ceiling fixtures of the flush type are used in vestibules, toilets and passageways.

A horizontal headlight and a vertical-beam light are provided, these being in a housing on the roof over the operator's cab. An electric speed indicator is provided, driven from the end of the axle of one of the power trucks, with a dial mounted on the instrument board in the cab. Electric circuit connections between the units is by means of receptacles and jumpers.

Marker lights, consisting of double lights on each side of the car close to the rear end of the train practically flush with the contour of the exterior, are provided. One red lens and one green lens is used on each side of the car, so arranged that each light is controlled independently. This permits a green light to be shown on one side and a red light on the other side at the same time, if so desired. These lights are wired to the battery circuit. Classification lights are provided at the front end of the operator's cab on each side of the car, fitted with white and green lens.

The cab is provided with electric window wipers on each of the two front windows; two circulating fans on adjustable brackets are applied to keep the windshields from steaming up or frosting. The signal system consists of a buzzer in the operator's cab connected to push buttons, one conveniently located adjacent to each side door. Warning devices consist of a horn and a bell. A horn also is located at the rear end of the train for use during backing up operations.

Failures of

Locomotive Parts*

By Fred H. Williams†

Side rods - Failures at the keyway caused by sharp corners and poor machining

LOCOMOTIVE failures are not only costly, but frequently interfere seriously with scheduled train operations. No reasonable expense should be spared to reduce them to a minimum. While a certain percentage of failures is, of course, due to poor material, a surprisingly large number are caused by improper machining and finishing. The railways can afford to go to considerable lengths in the way of research to determine the causes of the failures and to institute proper measures for their elimination.

This article, and others which will follow, are based upon a thorough examination and study of locomotive failures over a period of many years.

The great dragon that appears most frequently is that old fellow "fatigue crack." It appears under various conditions and in most cases is preventable if proper precautions are taken concerning details which may appear to be quite insignificant. Poorly formed keyways, for instance, cause much more trouble than most railroad men realize. This is particularly true in the case of locomotive side rods. The location of the keyway in the forked end of a side rod is usually such that it does not appear to be a source of weakness; yet a careful study of side rod failures indicates that it is a prolific source of trouble.

The illustrations which accompany this article show clearly the type of cracks which start in keyways. A side view of a side rod with a fatigue crack starting from the corner of a keyway is shown in Fig. 1. The two faces of the break indicated in Fig. 1, are illustrated in Fig. 2. The crack started from the keyway and progressed slowly at first, and then more rapidly, as indicated by the width of the waves of the progressive crack, which is what is known as a fatigue crack. Due to the fact that the faces rubbed together and polished each other when the crack was started, the surface is much smoother at the first part of the break. The farther the crack progressed, the coarser the waves and the rougher the surface, until when the failure finally occurred the surface is very coarse.

This is a fatigue crack, although those who are not thoroughly familiar with it frequently report such failures as due to flaws in the metal. Heat cracks or checks are in turn sometimes mistaken for fatigue cracks, although they can readily be distinguished by a critical examination of the broken part. The starting of a fatigue crack is generally very fine and is quite likely to be overlooked.

In Fig. 1, the crack started at the corner of the keyway. It may have been due to a tear in the metal or a sharp cut in the corner that concentrated the stresses in a line. This causes the metal to part, little by little, until the section is so weakened that the strain on the rod is sufficient to cause the break. Only a small part of the rod is shown in the photograph; it is expensive to send cracked and broken rods from distant parts to the test office, and usually a small part, sufficient to show the crack or break, is cut from the rod and shipped in.

Another failure of the same kind, except that it is on one of the forked ends of the side rod, is shown in Fig. 3. The keyway in one side of the fork was cut with square corners; the crack started in one of these and worked its way across the section with the usual characteristics of a progressive, or fatigue crack. The fractured ends of the break in Fig. 3 are shown in Fig. 4. Apparently metal torn out in the corner of the keyway caused the start of the crack. A close examination of the photograph indicates the usual waves which started in the corner and progressed slowly inward. In this instance they are clearer at the start of the crack than at the finish, indicating that the crack opened up at the start and that the final face of the fracture rubbed for some time after parting, thus wiping out the progressive marks which are so clearly shown in Fig. 2.

Another interesting example is shown in Fig. 5. Here we find two cracks, one of which resulted in a fracture. The fractured ends are shown in Fig. 6. The crack, which resulted in the fracture, apparently started first and is known as a primary crack.

Use Fillets in Corners

Obviously the remedy for failures of this sort is to leave fillets in the corners of the keyways and avoid all sharp corners. These fillets should have smooth surfaces and be free from any tears in the metal that may start cracks. Incidentally, the broken sections in Fig. 6 indicate that the fatigue crack started from both sides and at the corners of the keyway.

Another example of a fatigue crack which started in the sharp corner of a keyway and which could have been avoided by the use of a fillet, is shown in Fig. 7. Chalk marks were made on either side of the crack in the attempt to throw it into relief. Another fatigue crack, which started in the corner of the keyway in a forked rod, is shown in Fig. 8.

Fatigue cracks do not always start in the corner of the keyway. This is illustrated in Fig. 9, where the crack is some distance from the corner and was apparently started from a tear, caused by rough milling operations.

Machining Important

It is important, therefore, that the keyways not only be well filleted, but that they be machined with a smooth and fine finish. The use of alloy steels in place of carbon steels does not remove the necessity of filleting the corner of the keyways and having a finish which is smooth and free from tool marks. While the alloy steels are stronger, they are more sensitive and therefore require a smooth finish. It is ridiculous, is it not, for one to make tests of material with the test

* This is the first part of an article dealing with failures of locomotive parts. The remainder of the article will appear in a subsequent issue.

† Assistant test engineer, Canadian National Railways.

pieces finished with a high polish, and then use a rough finish on the finished product which shows tool marks?

In conclusion it may be said that the type of failure illustrated in this article is not at all uncommon.

In examining some test pieces of a rather intricate design in a plant which maintains the highest possible standards, I was told that the test pieces failed to meet expectations. An examination of the fracture seemed to indicate that the failure was caused by rough

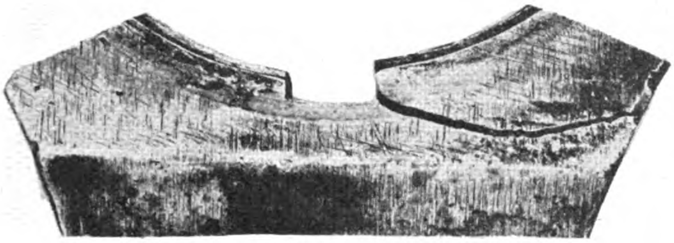


FIG. 1

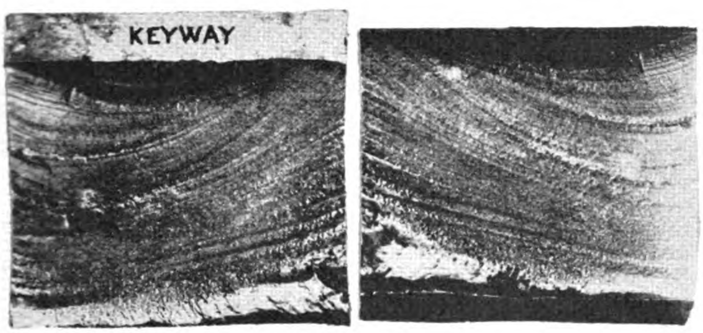


FIG. 2

FIG. 3

FIG. 4

FIG. 5

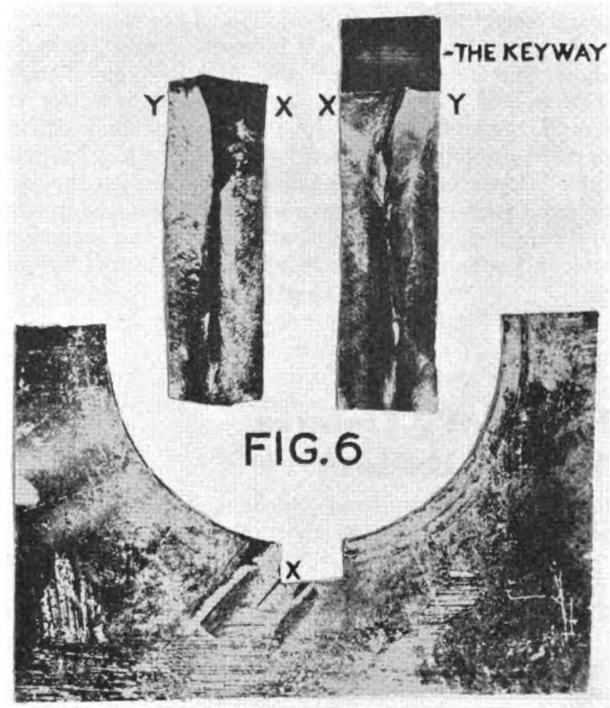


FIG. 6

FIG. 7

FIG. 8

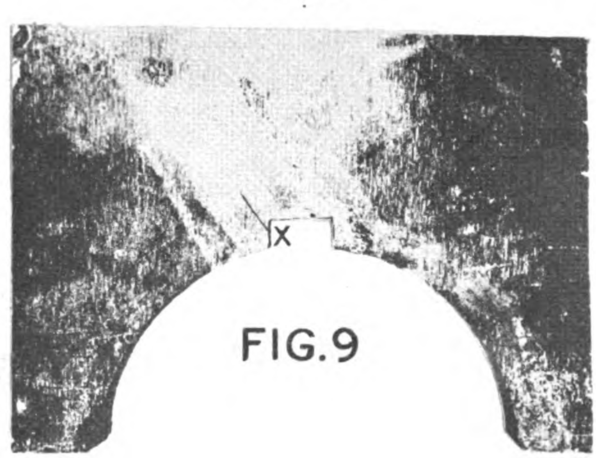


FIG. 9

Failures at keyways in side rods

Fig. 1—Side view of a piece of a side rod, showing fatigue crack which started at the corner of the keyway; Fig. 2—The two faces of the break in the side rod, which is shown in Fig. 1; Fig. 3—Side view of fork on side rod, showing fatigue crack which started from the corner of the keyway; Fig. 4—Faces of the break of the side rod, which is shown in Fig. 3. The crack started in the corner of the keyway at X; Fig. 5—A fatigue crack started in each corner of the keyway. The one at the left progressed across the full section, while the one at the right extended only a short distance; Fig. 6—Fractured ends of the side rod shown in Fig. 5. While not clearly shown on the photograph, this fatigue crack started in two places, X and Y; Fig. 7—Another fatigue crack in a side rod, which started in the square corner of the keyway at the left; Fig. 8—A fatigue crack which started in the sharp corner of the keyway; Fig. 9—This fatigue crack started from the side of the keyway, rather than in the corner, and apparently was caused by rough machining.

machining, as indicated by tool marks. I was told that the fracture was a typical torsional one only, since the surface was ground smooth. An examination with a microscope, however, revealed that about one-half inch of the surface, which was hard to get at, was comparatively rough machined; the tool marks could be plainly seen and the crack followed these marks.

A careful check-up of failures would undoubtedly show that many of them are due to poor machining. The use of a little fillet, together with a better finish, would prevent failures in the keyway and cause the part to function successfully indefinitely. In general, fully 90 per cent of the failures are due to the lack of proper machining and finishing the parts in the first place, and to a lack of proper maintenance in the second place, and only about 10 per cent are caused by poor material.

(*To be continued*)

Frank W. Thomas—Morale Builder

Readers of the *Railway Mechanical Engineer* over the past three decades—and there are not a few of them—recognize the A. T. & S. F. as one of the leaders in modern shop apprenticeship training. Frank W. Thomas, engineer of tests of the Santa Fe when John Purcell transferred him and assigned him to the building up of the new apprentice training system in 1907, recently retired from service. Many tributes were paid to him by a large circle of friends and well wishers. A supervisor on the Santa Fe, noticing an announcement of Mr. Thomas' retirement in the Santa Fe Magazine, was inspired to send up a letter about his own experiences, from which the following is quoted:

"I learned of the apprentice system from a boy who had moved from our town out on the branch to the division point, and decided to try to get one of those jobs. I went before the mechanical superintendent and explained to him that I wanted a job and that about all his district lacked of being perfect was to hire me. And although shaking from head to toe I finally got the idea before him. They were not very particular in those days; in fact, they hired and fired regularly and I was hired as a machinist apprentice.

"I received some instructions regarding various rules and regulations and safety matters and went to the tool room to work at the counter and, incidentally, to learn the names of the multitude of tools and also that switch lights are *not* filled with red oil and green oil mixed in equal parts to give the proper indication on the switch lights.

"A course in school room work went along with the shop work and to make things interesting, the instructor announced that he was sending from time to time a few of the best drawings to Mr. Thomas. This stimulated a lot of rivalry among the apprentices and resulted in a number of very good drawings, which were always acknowledged by Mr. Thomas with suggestions that invariably induced better work.

"The courses of study were revised from time to time with a view of giving the best training possible and to build thoroughly from the ground up, so to speak.

"About 1918 the first apprentice club was organized, with the idea of providing entertainment of the right sort for young men in the formative years. It was my privilege to be elected president of the first club and when we gave a 'blow out' invitations were mailed to all the higher officers of the mechanical department. Among my souvenirs of those days is a letter from Mr. John Purcell, regretting he could not attend on the date set for one of the entertainments.

"In the course of time apprentice activities branched out into athletics and the larger division points soon formed baseball, football and basketball teams. The details of the various sports were worked out locally, but the guiding hand and the power behind the throne was none other than Mr. Thomas. Questions arose from time to time regarding the eligibility of players, etc., on account of the fact that some of the smaller shops were forced to use men other than apprentices to complete a team. When these matters were put up to Mr. Thomas for a ruling, it goes without saying that he promptly handed out a decision that covered the situation from every angle, and some of them would have made Kenesaw Landis and Will Hays look like a couple of amateurs.

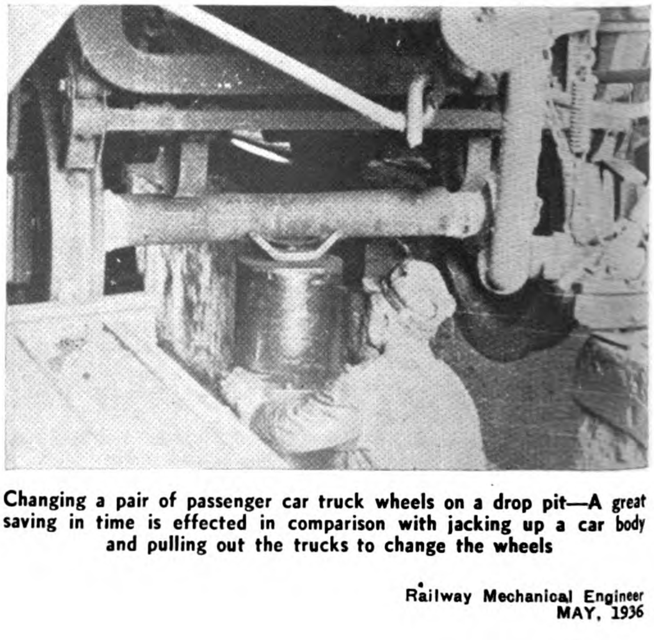
"Mr. Thomas' wonderful personality made many friends and it was always a pleasure to learn via the roundhouse grapevine that he would be in town for the day. He knew all the foremen and instructors by their first names and would go through the shops and roundhouses never overlooking an opportunity to drop a little praise or comment here and there, that seemed to get results without any chafing at the collar anywhere along the line.

"As I look back on the past I feel safe in saying that after one of Mr. Thomas' visits the morale of the place was up 20 points or more. His ability to keep up the morale of the apprentices to a high plane was instrumental in retaining the boys in service until they rounded out their four years apprenticeship, and at the end of that time they usually had acquired enough 'horse sense' to see the benefits of remaining in the service.

"The pep in the apprentice organization made for a good safety record, and it was very seldom that any apprentice suffered a personal injury, and in many cases they led the field in the matter of the fewest personal injuries. A wonderful record when you stop to consider that in most cases the individual was performing the job at hand for the first time, it is a fact that when the morale of the men is up, the accidents are down.

"Mr. Thomas set and maintained a high standard in his work and his reputation for fair dealing and honesty easily distinguished him as a gentleman in every respect. He gave railroading the human touch and the Santa Fe will reap benefits for many years to come from the good work of Frank W. Thomas—Gentleman from Virginia."

* * *



Changing a pair of passenger car truck wheels on a drop pit—A great saving in time is effected in comparison with jacking up a car body and pulling out the trucks to change the wheels

Railroad Diesel Engineering*

By A. H. Candee†

In general construction the gasoline and Diesel engines are nearly identical. The former, however, draws in its fuel in the form of a gas, the gasoline being vaporized and mixed with the proper quantity of air. This fuel mixture is then compressed and fired by an electric spark. The Diesel engine draws in nothing but pure air, and, after this pure air is compressed, the fuel is sprayed into the cylinders in a very fine vapor and fired by the heat generated by compressing the air. This method of introducing the fuel is the fundamental difference between the two engines and is responsible for the much higher thermal efficiency of the Diesel engine. In the gasoline engine, the maximum compression of the gas fuel mixture must be low enough to guard against pre-ignition of the charge due to heat of compression. In the Diesel, the compression pressures may be much higher because only air is involved. The higher temperatures and pressures in the latter case result in greater efficiencies. This also means that the engine parts must be slightly heavier to withstand the higher pressures.

The Diesel engine "grew up" as a marine engine—slow speed for direct connection to propellers and weight of minor importance. Few Diesel manufacturers could foresee sufficient field for the high-speed light-weight Diesel engine to warrant the high expense of development. The application of such engines to rail propulsion, however, necessitated small dimensions and light weight and, with growing demand, such engines have been developed. The Westinghouse engine, the first commercial rail-car engine, weighed around 30 lb. per hp., which compared very favorably with contemporary gasoline engines of similar size, and was a long step forward. This development has been a contributing factor toward the adoption of Diesel engines for rail propulsion purposes.

Within the last four years, the Diesel engine has been given serious consideration by the railroads. It has proved its effectiveness as a source of motive power and has demonstrated that it will actually reduce operating expenses both in rail-car work and in switching work. The trend of the times has also been conducive to its adoption, especially in rail-car work. A period of industrial stagnation always brings out radical ideas of all kinds, both politically and mechanically. New steels have been perfected; new methods of fabrication have been developed. New ideas of all kinds are rampant. The growth of air passenger traffic, even during the depression, has focused the attention of the public on aerodynamic construction and has had its effect on railroad train construction. The public preference for fast service, as evidenced by the air traffic growth and the stepping up of automobile speeds (40 miles per hour was fast road driving in 1925) has led some of the railroads to the conclusion that the provision of fast train service would be welcome, especially from Chicago to the western cities. Consideration of such fast trains led to the adoption of light-weight construction, streamlining, articulation and the Diesel engine, since these features bring the power requirements down within the range of present engine construction.

The development of the modern streamlined passenger train may be definitely traced to rubber tires. The Michelin tire, as brought out in France for rail purposes and later tried in this country, necessitated light-weight car construction. To construct such light-weight cars, a new method of steel fabrication was developed in this country. With the increase in car weights and the consequent abandoning of rubber tires, the new fabrication methods were retained. This experience in light-weight construction and reduced cross sections of cars pointed the way for further combination of such construction and aerodynamic lines, which puts the power requirements, even for high speeds, within the range of Diesel engine capacities. Thus, the so-called high-speed streamlined trains which have been operated or are on order, are

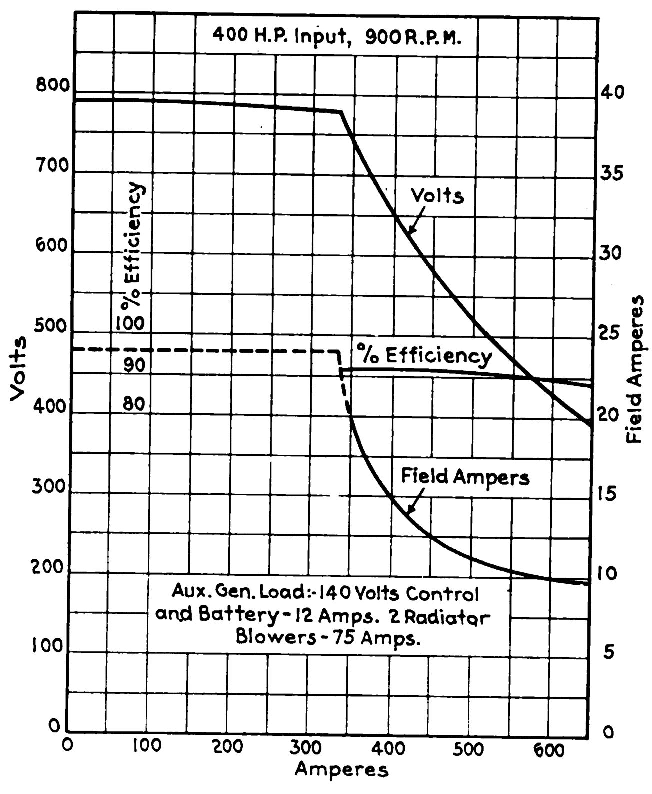


Fig. 1

Diesel-engine driven. As a matter of fact, increases in speeds of railroad trains are not as much a function of light weight construction and streamlining as of grades, curves and traffic hazards. The only difference between a light-weight streamlined train and a conventional train is in the amount of power required for propulsion, and the present steam motive power is adequate to pull any normal train at as high a speed as these limitations will allow.

* This is the first part of a paper presented at the Massachusetts Institute of Technology, March 16, 1936, dealing with the engineering considerations involved in the application of Diesel railroad motive power to rail transportation problems. The remainder of the paper will appear in a subsequent issue.

† Diesel-electric engineer, Westinghouse Electric & Manufacturing Company.

The transmission of power from a prime mover to the wheels of a locomotive or rail car has been the subject of a great amount of thought. Mechanical transmission from reciprocating steam engines is simple, and has been proven to be practical and reliable. Transmission of power from internal-combustion engines, however, is not as simple, since the prime mover cannot develop torque at zero speed. Among the systems proposed and tried are: mechanical drive (clutches, change gears, universal joints, etc.); hydraulic transmissions; pneumatic drive, and the electric transmission.

The apparent simplicity of the mechanical system gave it an advantage during the early stages of self-propelled rail car and locomotive development. With the gradual increase in engine sizes and train weights, every opportunity was afforded to develop such transmissions, and, as an actual fact, they were used with some success up to 175 hp. engine sizes. In spite of the intensive development, such transmissions have not persisted in the larger engine capacities, and nothing spectacular has appeared to date to show a reasonable expectancy of results better than have already been found.

Mechanical transmission involves a number of problems which have not, as yet, been successfully solved for large horsepowers (above 150 hp.) and which are troublesome in even lower horsepowers:

1—Transmission from a spring-borne body to a swivel truck.
2—Transmission to an axle, one end of which may move up or down (with rail joint depression, etc.), and which has some lateral movement in the truck, as well as longitudinal movement in the journal-box guides.
3—Engine mounting on the truck to reduce the problems of (1), result in high engine maintenance.
4—Gear-shift transmission results in poor utilization of available engine power. Thus, each time the gear ratio is changed, power must be completely removed and engine speed dropped to approximately half speed (and half horsepower), following which the engine must accelerate the load to regain full horsepower. This is often impractical with varying railroad grades and results in long operation in an uneconomical gear ratio.

In spite of numerous attempts to use it, no hydraulic transmission has yet been found adequate for railroad service. The main difficulties are due to low efficiency, high maintenance, oil leakage and emulsification of the oil.

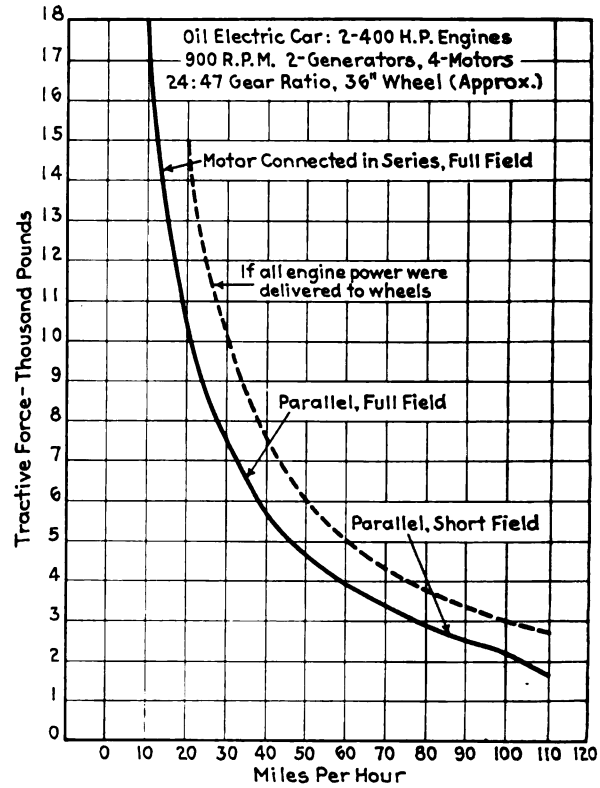


Fig. 3

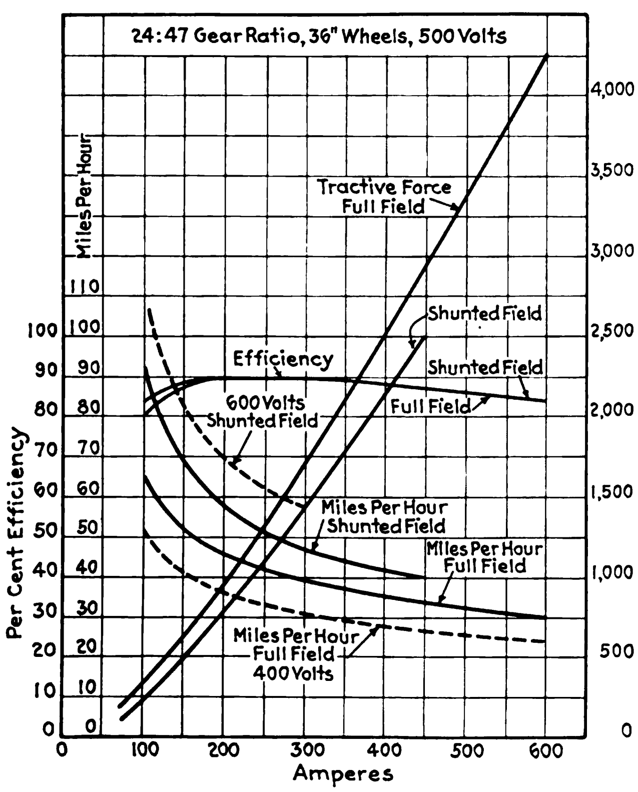


Fig. 2

There have been numerous attempts to employ compressed air for power transmission purposes. The fact that these attempts have resulted in no extended use of this system speaks for itself. Other freak drives (such as combinations of steam and Diesel drives) have not as yet attained a commercial status.

The only satisfactory system of power transmission for internal-combustion rail motive power is the electric system. The reasons for this are:

1—Low maintenance costs as compared to other transmissions.
2—Less physical labor for enginemen in control.
3—Greater overall efficiency and engine power utilization.
4—Maximum tractive force and maximum speeds not a function of the engine.
5—Simple to apply power to multiplicity of driving axles.
6—Operation of auxiliary apparatus is simple.
7—Double-end or multiple-unit control is simple.
8—Power plant may be located in the most advantageous position.
9—Every engine has one or more critical speeds. These may be avoided by electrical transmission.
10—Experience has proved the economy and reliability of this system.

Essentials of Electrical Transmission Systems

The essential elements of an electric transmission system are a generator driven by the engine, traction motors for driving the vehicle, and a control system for connecting the traction motors to the generator, reversing the direction of movement, and regulating the power output of the generator. The main generator is usually built with an auxiliary machine or exciter mounted on the same shaft to generate electrical energy for excitation and for auxiliary purposes.

For simplicity of control, nearly all electrical transmission systems generate and use direct current at voltages (depending upon individual designs) from 600 to 1,000 volts maximum, although the voltage may be selected to give the most economical design. Since the

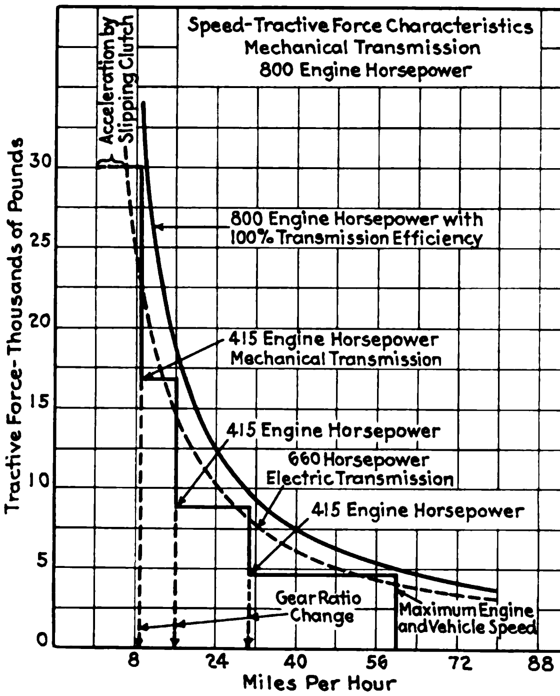


Fig. 4

power of the engine is constant and the tractive force (current) requirements of the traction motors are exceedingly variable, the generator voltage must also be variable over a wide range. This is shown by Fig. 1, which is the characteristic of each generator of the New Haven's train, the "Comet." The Diesel-electric generator is normally a separately excited commutating pole machine, the armature being wound with Class B insulation. A differential series field is sometimes provided for regulating the load to match the engine capacity, but due to the size increase of the generator when this differential field is included, most designers prefer to have the load-regulating means external to the main generator. Another series field is provided in these machines to permit the main generator to act as a series motor for starting the engine, receiving its power from a storage battery.

The mechanical connection of the generator to the engine may be made in several ways. The frame of the machine may be bolted directly to the engine crankcase or may be mounted on a common bed with the engine. The latter method appears to have some advantages over the former. Some of the early generators were of the two-bearing type, but it is now common practice to build single bearing machines with the armature supported at one end by the engine crankshaft. The coupling between the engine crankshaft and the generator armature may be rigid or have alignment flexibility, but rotational flexibility is apt to be dangerous because the resonant effects induced by the engine pulsating torque may set up severe stresses in the shafting.

The traction motors used for Diesel motive power are of the series type, but differ to some extent from those used for electric trolley systems, in that the ratio of core losses and copper losses may be readjusted, because, with Diesel motive power, high currents and high voltages may not occur simultaneously within the power of the engine. This means that core losses higher than would be considered acceptable for trolley systems may be tolerated if the resultant design permits a reduction of copper loss. This theory of design has resulted in motors having a high weight efficiency. As far as mechanical design is affected, the chief difference between the motors for Diesel equipment and for trolley systems is that axle bearing sizes have been increased for the Diesel applications because the additional weight of power equipment necessitates the use of larger axles. Fig. 2 is the characteristic curve of each of the traction motors as used on the "Comet." While this motor is rated at 500 volts nominally, it may be noted that the generator develops nearly 800 volts and the motors operate at this voltage. Fig. 2 shows the effect of 400, 500 and 600 volts impressed across the motor, also the resultant increase in speed by shunting of the motor field.

The actual performance of the equipment with a generator having a characteristic as shown by Fig. 1 and two motors having characteristics as shown by Fig. 2 is shown by Fig. 3, this curve being plotted in terms of speed and tractive force. This same general shape of curve is characteristic of all Diesel-electric equipments, where the power of the engine limits the performance. It may be noted that since horsepower is the product of miles per hour and tractive force divided by 375, the full horsepower of the engine, if plotted, would be a true hyperbola. The deviation of the performance shown by Fig. 3 from that true hyperbola is due to variable efficiency of the electrical equipment with varying speed and current conditions. Another interesting point in connection with this curve, as compared with a performance curve of motors operating from a constant potential trolley system, is that changes in gear ratio or in wheel diameter can change this performance but slightly over that portion of the curve below the full generator voltage, such changes only resulting from slight alterations in the efficiency of transmission. It may be noted that this curve is formed of four distinct parts, the first showing the motors to be connected in series across the generator, the second with motors in parallel, the third with the motors in parallel and their fields shunted, and the fourth portion is the same as the third except that the motors operate at constant voltage.

It is customary to connect the traction motors in series during the early stages of an acceleration. By this expedient, the current drawn from the generator is half of that required if the motors were connected in parallel, and thereby the losses in the generator are reduced. This

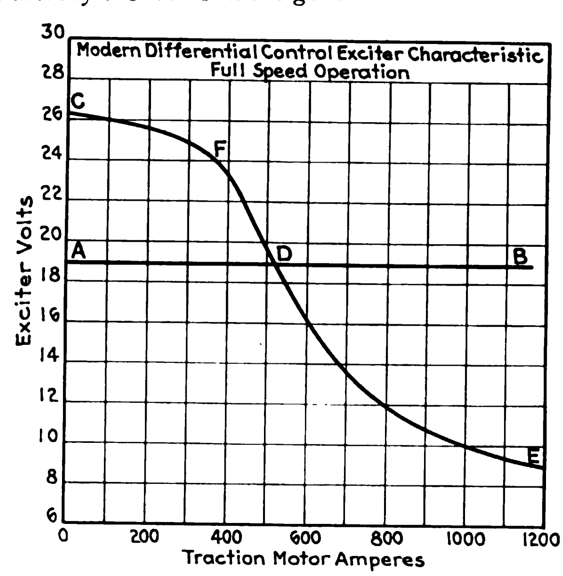


Fig. 5

improves the equipment performance materially over the heavy tractive force range of an acceleration.

Following an acceleration through from a start to full-speed running, the motors are first connected in series relation across the generator with the engine idling, after

which the engine speed is gradually raised at a rate sufficient to maintain the desired accelerating tractive force until full engine speed is attained. From this point, all further increases in train speed are accomplished by electrical changes. As the train continues to speed up (and consequently the motor current decreases), the generator field is increased to raise the voltage gradually so as to keep the engine fully loaded until full generator voltage is reached. At this point, the traction motors are connected in parallel relation and the generator voltage is decreased to half voltage, again being raised gradually to full value. The next operation is to weaken the traction motor field, which may be accomplished by connecting a non-inductive shunt across them, thereby increasing the current demand, which requires another drop and gradual increase in voltage. With full voltage attained under these conditions, the motors operate at constant voltage for any further speed increase.

Mechanical and Electrical Transmission Comparison

It may be of interest to compare the performance of a mechanical system of transmission, driving through gears, with that of an electrical system. In order to provide for variable ratio of engine torque to propulsion torque, it becomes necessary to build the gear drive with gear-ratio changes, and for mechanical reasons it is desirable to limit the number of such shifts to a minimum. This results in poor utilization of the available engine power. Reference to Fig. 4 indicates that each time the gear ratio is changed, power must be completely removed and the engine dropped in speed (and horsepower), following which the engine must accelerate the complete train in order to regain full engine speed and horsepower. This is often impractical with varying railroad grades and may result in long operation in an uneconomical gear ratio. Comparing this with an electrical system of transmission (as shown by the dotted curve), it may be seen that the latter system corresponds to a geared system having an infinite number of ratios, and, although the efficiency of the drive may not be as high as that of the mechanical system, the general utilization of engine power throughout the range of train speeds is much better. The electrical system adapts itself exactly to the loads and to the grade conditions of the railroad.

Auxiliary Details

Among the items which form any complete Diesel-electric motive-power equipment for a car or locomotive are such auxiliary equipment as:

1—Radiator cooling fans and drive.
2—Air-brake compressors.
3—A storage battery for engine starting, emergency lighting, and control.
4—An auxiliary generator for the supply of auxiliary power, field excitation, and battery charging.
5—A system of control for proper engine loading and for control of auxiliary functions.

Other auxiliaries are sometimes provided for special purposes, such as a train steam-heating plant and air-conditioning equipment.

In most of the modern Diesel motive-power equipments the radiator fans are electrically driven. The motors operate at relatively constant voltage from the auxiliary generator whether the Diesel engine is idling or delivering traction power, except that they may be disconnected automatically or manually if the water or lubricating-oil temperatures fall too low for the best conditions of engine operation.

The air compressors used for electric locomotives or cars are normally air cooled. For Diesel motive power, however, where a water cooling system is available, water cooled compressors may be employed and may be mounted in a more convenient location because ventilation is not necessary. Single-stage water-cooled compressors may be used for the higher-pressure and higher-capacity braking systems which would require two-stage compressors if air cooled.

The capacity and voltage of the storage battery is generally determined by the starting requirements of the engine, although there are some cases where air-conditioning requirements have determined this size. In starting an engine the torque required to turn the engine initially with cold bearing surfaces determines the maximum current capacity, and the firing speed of the engine fixes the minimum battery voltage. An 800-hp., 12-cylinder Diesel engine requires a 54-cell lead battery of 235 amp. hr. capacity.

The auxiliary generator or exciter is usually driven by the main engine, the frame being mounted on the bearing housing of the main generator and the armature being pressed onto an extension of the main-generator armature shaft. This construction eliminates the necessity of bearings for this machine. In some installations this auxiliary generator has been driven by a separate engine. The voltage of this machine is determined by the maximum voltage required for battery charging and its capacity by the auxiliary load connected to it.

The air-brake systems used on Diesel motive power are fundamentally the same as are used on electric locomotives and cars. Some modifications and refinements have been incorporated in brake equipment for high-speed trains because of the wide range of speed through which such trains operate.

Control Systems for Electrical Transmissions

One of the most important design features in the production of Diesel electric railway drives is the system of control employed for proper utilization of the engine power. Among the factors which must be considered are:

1—Engine power must be utilized to the fullest extent because the engine capacity which may be applied is necessarily limited.
2—Control must not overload the engine, because this results in smoky exhaust and high engine maintenance.
3—Application of power to the traction motors must be well regulated to prevent rough train operation.
4—An adequate supply of power must be available for the operation of auxiliary equipment and battery charging.

In general, there have been three major systems of control used in the past:

1—Separate manual engine-speed control and manual variation of generator-field strength.
2—Manual variation of engine speed and windings incorporated in the generating equipment for automatic variation of the main-generator voltage.
3—Manual variation of engine speed and external regulating means for varying the main-generator voltage in accordance with the current demands of the traction motors.

It may be noted that each of these systems includes means of varying the engine speed. It has been found advisable to operate the engine at its minimum permissible speed when propulsion power is not required, in order to reduce lubricating-oil consumption, fuel consumption, engine wear, and to minimize noise. Also, since it is not always necessary to operate the engine at full speed in order to obtain the power required to move a train, it has been found expedient to arrange the control system to obtain any intermediate speed between idling and full speed.

Manual Load Regulation

Manual variation of the main generator field to obtain maximum voltage permissible (within the power

of the engine) for the varying traction-motor current demands theoretically gives excellent control of the engine power output, but requires considerable attention on the part of the operator and that he be located adjacent to the engine so that he may tell by the sound of the engine when it is being overloaded. This system, however, was found to have practical objections because the operator's duties required that his attention be on other things. This led to the development of automatic loading-control schemes.

Differential Control

The early control systems of the gasoline-electric rail cars built subsequent to the war were based on the regulation of generator voltages by means of differential field windings. The first of these was a straight differential field (carrying motor current) on the main generator. The main disadvantages of this were the large increase in main generator size for a given output and its poor engine loading characteristics. When it is considered that the volt-ampere curve of a generator for constant engine output must be hyperbolic (concave) in shape and that the regulation by such a differential field is convex in character, it may be readily seen that it is difficult to produce satisfactory engine loading except over a very small range of voltage. An improvement over this was brought out by Westinghouse in 1925, wherein the differential field is placed on two poles only of a six-pole exciter. This means that the increase in size of the rotating machinery made necessary by the use of the differential winding, is confined to a relatively small unit, and the total increase in generating equipment weight and cost is small. The chief feature of this design, however, is a generator output curve which is nearly hyperbolic in shape, resulting from the winding of the differential field on but two poles of the exciter and saturating these poles. Thus, if it is considered that the separate excitation of the exciter is from a battery, it may be readily seen from Fig. 5 that the voltage generated in the exciter armature by the four unsaturated field poles is relatively constant, as shown by line AB. Also, voltage generated by the two saturated poles when no motor current flows, adds to this 4-pole voltage but is limited by the magnetic saturation of the pole pieces. Now, it is obvious that at some definite value of motor current flowing through the differential winding, such as at the point D, the flux through the two poles is zero, and therefore the resultant voltage lies along curve AB and that as the motor current increases, these poles again saturate in the reverse direction. With this design, the portion of the curve from F to E may be made approximately hyperbolic in shape, and since this machine is used for exciting the main generator, this characteristic is reflected in the output of the power plant. This general idea is used in practically all modern differential control systems.

(*To be continued*)

Illinois Central

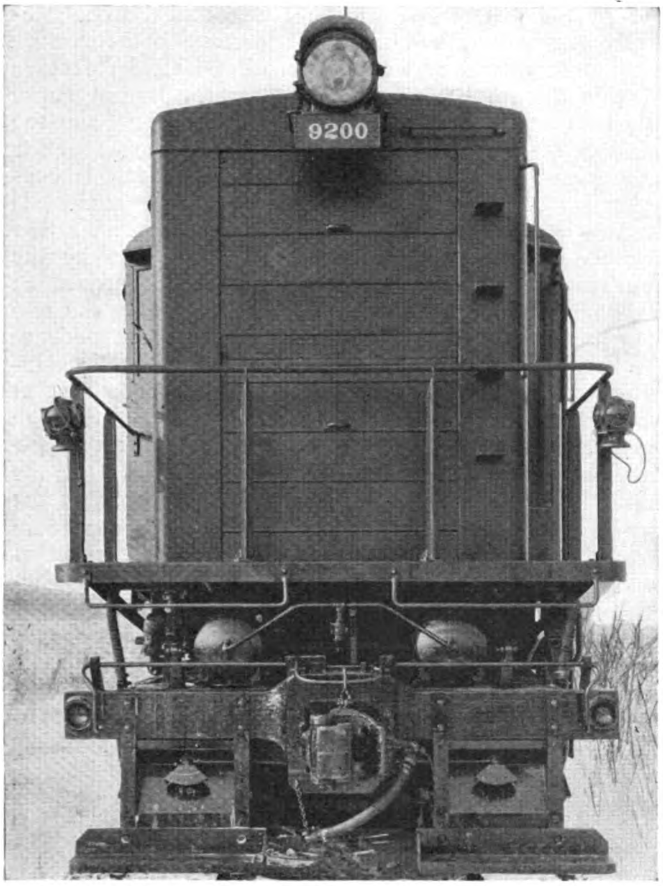
1,800-Hp. Diesel Locomotive

THE Illinois Central placed in service in March an 1,800-hp. Diesel-electric locomotive built for freight transfer service. The main power plants consist of two 900-hp. Ingersoll-Rand Diesel engines with General-Electric electrical equipment including generators, traction motors and controls. The total weight of the locomotive is 342,000 lb.

The power plants are mounted on a welded, fabricated-steel underframe the principal members of which consist of four H-beam sections 24¼ in. deep, weighing 120 lb. per ft. The cab is of steel, welded, with radiators at each end for cooling the circulating water and oil from the engine.

The entire locomotive is carried on two six-wheel

Illinois Central 171-ton, 1,800-hp. Diesel-electric locomotive



End view of the locomotive showing the cab and truck arrangement

power trucks having Commonwealth cast steel frames. An interesting feature of these trucks is the fact that the draft gear is attached directly to the trucks. By this design pulling stresses are carried through the underframe for only one truck.

The Diesel Engines

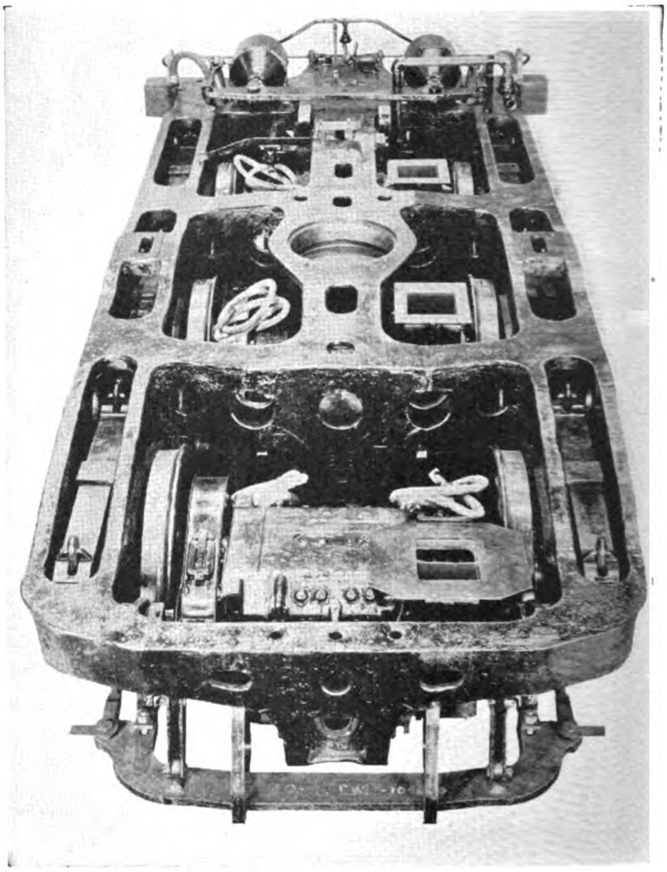
The Ingersoll-Rand Diesel engines are of the six-cylinder vertical trunk-piston, single-acting type operating on the four-stroke cycle with direct fuel injection. The bore and stroke are 14¾ in. by 16 in. They have a rated output of 900 brake hp. at 550 r.p.m. The engine sub-base is of welded steel construction and extends the full length of the engine housing forming the oil sump and support for the entire engine. The engine housing is a steel casting bolted to the sub-base and forms the main support for the crankshaft, camshaft and cylinders.

Each of the six cylinders is a separate casting with integral water jackets, which are provided with eight hand-holes for cleaning. Cooling water enters the cylinder jackets at a point about two-thirds the distance from the bottom of the jacket to the top of the cylinder.

The cylinder heads are constructed so as to incorporate the inlet and exhaust manifolds. The adjoining sides of the heads are flanged and are bolted together with a metal-to-metal joint. One injection spray nozzle is held by clamps in each side of the head. The cylinder heads each contain one inlet and one exhaust valve which are actuated by push rods and rocker arms mounted on the heads. The valve actuating mechanism is completely enclosed and is lubricated by oil under pressure. The inlet valves are of low-carbon steel and the exhaust valves are of silchrome steel. Each valve has two coil springs.

The crankshaft is a one-piece steel forging having six cranks and seven main bearings. The crank pins are hollow and the crank shaft counterweights are secured to the butt end of each crank arm. The camshaft is driven from the generator end of the crank shaft through spur gears. The camshaft assembly includes the governor gear, inlet- and exhaust-valve cams, fuel-pump cams and over-speed governor.

One of the seven main bearings serves as a lateral thrust bearing. The connecting rods are forged steel machined all over. The piston-pin bearing is a bronze-lined bushing pressed into the eye of the rod. The connecting rod bearings are interchangeable steel shells lined with babbitt. The pistons are one-piece steel castings with babbitt on that portion of the skirt below the bottom compression ring. The top of the piston is so constructed as to form the combustion space. The piston pin is of the full-floating type and is located endwise by cover plates on the piston, held by a through bolt. Each piston is provided with five compression rings



Top view of the six-wheel truck showing the traction motors, spring arrangement and brake equipment

above the pin and two ventilated oil-drain rings below.

The engines are equipped with six Bosch fuel-injection pumps which deliver properly timed and measured quantities of fuel to the cylinders. The fuel injection pumps receive fuel at low pressure from a header extending along the engine. Each pump delivers fuel at high pressure to the two spray nozzles of the cylinder which it supplies. The spray nozzles, each having a single orifice, are located on opposite sides of the cylinder head and direct the fuel into the combustion space.

The speed of the locomotive is controlled from the operator's position at either end of the locomotive by a manually operated throttle, which is mechanically connected to the oil-engine governor. A Woodward governor, driven by bevel gears from the camshaft, con-

trols the engine speed through a mechanical connection to the fuel injection-pump control shaft.

The connection between the engine and generator is a flexible coupling of the laminated-disc type which takes care of any angular misalignment between the engine and generator. The weight of the armature is divided between the flexible coupling and the generator bearing.

All moving parts of the engine are lubricated by a pressure-feed system supplemented by splash and sprays from the pressure-lubricated parts. The lubricating-oil supply is stored in the sump of the engine sub-base. Oil pressure is regulated by a spring-loaded relief valve in the oil piping between the engine and the cooling radiators. A lubricating-oil safety switch, wired into the electrical control circuit is provided to stop the engine in case of loss of oil pressure.

The engine cooling water is circulated by a centrifugal pump located at the front end of the engine which delivers cooling water to the cylinder heads, and thence to the radiators. From the radiators the water is piped back to the circulating pump.

The engine is started electrically by motoring the generator from energy supplied by the storage battery. While this is being done compression in the engine cylinder is released by a mechanism which holds the exhaust valves off their seats.

A centrifugal-type over-speed governor is driven from the camshaft and operates on a safety switch wired into the electrical control circuit.

General Characteristics

Total weight	342,000 lb.
Weight, per axle	57,000 lb.
Tractive force, continuous at 13.8 m.p.h.	38,800 lb.
Tractive force, one hour, speed 12 m.p.h.	44,400 lb.
Tractive force, 30 per cent adhesion, speed 3.7 m.p.h.	102,600 lb.
Maximum speed	60 m.p.h.
Length, between coupler knuckles	60 ft. 0 in.
Total wheel base	48 ft. 0 in.
Truck centers	37 ft. 4 in.
Rigid wheel base	11 ft. 0 in.
Truck wheel centers	5 ft. 6 in.
Wheel diameter	39 in.
Width over cab side sheets	10 ft. 0 in.
Heights from rail:	
Overall	15 ft. 2 in.
Cab floor	5 ft. 10½ in.
Capacity of fuel oil reservoir	1,150 gal.
Capacity of lubricating oil reservoirs, (one engine)	200 gal.

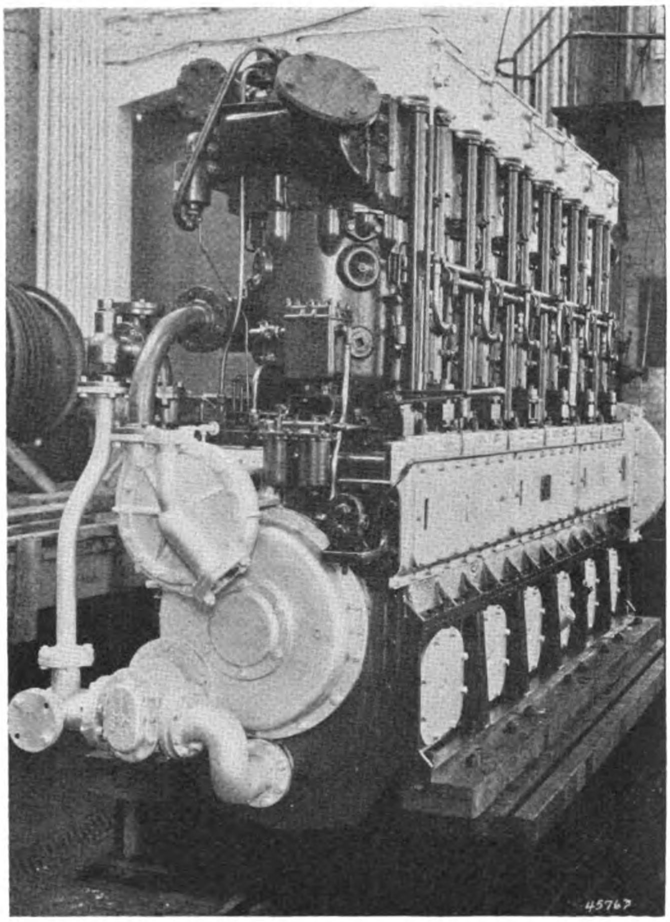
The over-speed safety switch contacts are connected in series with the lubricating-oil safety switch and a shut-down solenoid, which is mounted on the governor housing. When all of the contacts are closed and the electrical circuit is complete, the solenoid is energized and allows the fuel-injection pumps to be under governor control. Opening any of these contacts, or failure of the circuit will stop the engine.

Electrical Transmission

The two engines are placed side by side in the central portion of the cab and a traction-type direct-current generator is directly coupled to each of the engines, with a 125-volt constant-voltage auxiliary generator carried on an extension of the main generator shaft. Mounted on top of the auxiliary generator and belted to the main shaft is an exciter set which is used exclusively for supplying variable current to the main-generator fields. A flexible coupling is used between the engine and the main generator.

The traction motors are type GE-716, with a maximum gear reduction of 62 to 15. The design permits a maximum locomotive speed of 60 m.p.h., calling for a motor speed of 2,140 r.p.m. The motors are of the usual single-geared traction-type, the one side carried on the axle and the other supported by a flexible nose suspension on the truck transom.

Double-end General Electric Type P control equipment is provided, arranged for single-unit operation.



One of the Ingersoll-Rand 900-hp. engines

Should one of the engines be shut down, it is still possible to obtain maximum tractive force and thus to handle the usual weight of train, but at reduced speed, by cutting out the unused generator.

Auxiliary Equipment

The auxiliary generator providing 125 volts at all engine speeds, from idling to full speed, supplies power for the radiator-fan motors, traction-motor blower sets, air-brake compressors, lighting circuits, cab-heater motors, battery charging and excitation for the exciter.

The equipment in the main cab, in addition to the generating sets, includes two traction-motor blower sets, one for each truck, and two air compressors. The ventilating air is carried through a duct above the truck, which has a sliding connection above the air inlet to each motor. Underneath the cab is a 1,150-gal. fuel tank, the storage battery and the air reservoirs.

At each of the operating positions there is a throttle, master controller, gages, instruments, switch panels for the various auxiliaries and the usual air-brake equipment.

The cooling system consists of a three-sided radiator mounted in front of each operator's position, with a vertically mounted motor-driven propeller-type fan for exhausting the air upward from the radiator compartment. A feature of this equipment is the provision for circulating the water in the two radiators in series, thus equalizing the water temperature in the two engines. One of the three sides of the radiator compartment is used for cooling the engine lubricating oil, each engine being provided with a separate oil-cooling system.

The locomotive was built, equipped and tested, for the Ingersoll-Rand Company at the Erie Works of the General Electric Company.

EDITORIALS

Open the Flood Gates!

The mechanical department activities on a railroad are not only widely diversified, but are spread over great areas. As compared to more concentrated industries, only a comparatively thin line of supervision is maintained.

It is essential, therefore, if the best results are to be obtained, that the foremen and supervisors cultivate unusual administrative ability. While it is true that some of the forces are concentrated in considerable numbers in the back shops, even there the number of men per foreman is relatively large. In a car repair yard, in an enginehouse, or in similar operations, the forces are scattered over considerable areas. The wise foreman, and the one who possesses real executive talent, will use his best efforts to draw out and stimulate the special abilities of the men under him. Only in this way can he make a real success of his work.

Too frequently management overlooks the fact that a master craftsman may not possess leadership ability, and because men unfitted for such tasks have been promoted to positions of responsibility, the efficiency and effectiveness of a department may be seriously hampered. The boss cannot know everything about the detailed operations of his department. Only by getting the loyal and intelligent co-operation and support of every man under him, can he secure the best results.

If a boss is a "small" man, if he grabs off credit that belongs to others, he soon shuts off such sources of information and improvement and his department makes a poorer showing than it should. If, on the other hand, he frankly gives credit to his men for the good suggestions and the good records they make, he becomes a bigger man, and, with the enthusiastic co-operation of his subordinates, will establish new and better records of performance for his department. The trouble is that the "small" man cannot recognize that he is standing in his own light when he "hogs" the credit for suggestions made by others.

One of the most successful superintendents of motive power who ever served on an American railroad was Robert Quayle, of the Chicago & North Western. He insisted that the prime reason for his success was the fact that he invariably picked men as his assistants who were bigger than he was. Among his assistants at various times were Edwin M. Herr, who later went to the Northern Pacific as the head of its mechanical department, became general manager, then went to the Westinghouse Air Brake Company, and finally was president of the Westinghouse Electric & Manufacturing Company. Waldo H. Marshall, another of his assistants, later went to the Lake Shore & Michigan Southern as superintendent motive power, advanced to the position of general manager, and then became president of the American Locomotive Company. George R. Henderson was still another of his associates.

The railroads today are in a precarious condition. They have been subjected to the most severe regulation and have had their hands unfairly shackled in fighting their competitors. Now, in the decision in the eastern passenger rate case, the Interstate Commerce Commission is, in effect, attempting to take over managerial functions.

We have a large faith in the future of the American railroads, but it will depend upon real leadership on the part of all the officers and supervisors. The railroads must have the best efforts of every employee. Unfortunately, progress is being held up in many places by peculiar and narrow conceptions on the part of officers and foremen in dealing with the human element.

Men will always respond with the best in them if they are properly encouraged and directed. That the flood gates can be opened up has been demonstrated in the past by leaders who were big enough to listen to the suggestions of men under them and give proper credit for those suggestions which proved effective and really worth while. This at least is a large factor in successful management, either of a gang, a shop, a department, or the railroad as a whole.

Air Conditioning Summarized

On page 184 of this issue appears a table which is a summary of data published in the February, 1934, the December, 1934, and the March, 1936, issues of *Railway Mechanical Engineer* on air-conditioned cars.

The first three columns in Table I show that at the end of 1933 there were 648 air-conditioned cars in service. In the following year 1,872 more were added and in 1935 there were 3,347 more, bringing the grand total up to 5,867 by December 31, 1935. At the end of 1933 about 38 per cent of the cars were Pullmans. In 1934 this increased to 62 per cent. Air conditioning was initiated by the railroads, but the Pullman Company realizing its desirability for de luxe equipment proceeded to install it at a much greater rate than the railroads. At the end of 1935 the Pullman percentage had dropped to 55 indicating that the Pullman Company was getting a large part of its cars equipped and that the railroads as a whole were beginning to broaden the field of application as applied to railroad-owned cars.

During the period from December, 1933, to Decem-

ber, 1935, the percentage of ice-activated cars declined from 46 to 34. During the same time the percentage of compressor type systems increased from 48 to 53 and the steam-ejector installations increased from 6 to 13 per cent.

The data so far available can not be depended upon to indicate future trends, but it would appear that the ice activated cars were installed to meet demands quickly with a minimum first cost and that the compressor and steam-ejector systems have now been developed to a point at which they will limit the application of ice-activated systems and probably replace some of those now in service. It also appears that the railroads can be expected to broaden the application of air conditioning to include almost all types of passenger-train cars. There are now nine times as many cars equipped as there were at the end of 1933 and the bulk of the total does not consist of special service cars but rather of 2,404 sleepers and 1,122 coaches.

Light Weight And Safety

The idea that the new light-weight passenger equipment will actually operate without falling apart and so is safe when operated by itself is gradually being accepted by railroad men. The question still persists, however, as to what will be the result should collision occur between a train of light-weight equipment and one of conventional heavy rolling stock.

It may be stated at once that weight and strength are not necessarily synonymous terms. Where light-weight trains or coaches are designed to meet the same strength requirements as are the conventional heavy cars, the lighter cars for all practical purposes are stronger than the heavy cars. This is because both the energy stored in a moving vehicle and its momentum are directly proportional to the weight.

In the case of a head-on collision between two trains of equal weight moving at equal speeds, both trains are suddenly stopped and their total energy of motion absorbed either through distortion or failure of the parts of the structures. If one train, equal in weight to that opposed to it, is moving at a slower speed or, moving at the same speed, is lighter than the opposing train, it will store less energy and the amount of energy to be absorbed during the impact of collision will be reduced accordingly. Assuming that the structures as a whole do not fail, the surplus energy of the heavier or faster train will appear in a reversal of the motion of the lighter or slower train and the continuance of both at a reduced velocity.

If the time interval during which the impact pressure prevails is essentially the same in the case of a collision between a heavy and a light train as between two heavy trains, the force of the impact will be directly proportional to the weight of the lighter train (force times time equals mass times velocity). In the case of a rear-end collision between two trains of unequal weight, the change of momentum (mass times velocity) following the impact will be the same irrespective of which of the trains is struck and will be less than as though both were equal in weight to the heavier train.

It is evident, therefore, that a reduction in weight of either one or both trains involved in collision impacts effects a reduction in the destructive force of the impact as well as in the energy which must be absorbed. The smaller inertia of the light-weight cars or train, however, will tend to subject such equipment to more violent changes of velocity than the heavier equipment will experience. This may, in some cases, increase the destructiveness of the collision to the lives of the passengers in the lighter cars, although a question of degrees of violence of movement in such cases is somewhat academic. On the other hand, the higher ratio of strength to inertia of the light-weight cars will tend to reduce cases of telescoping, which frequently occur both in head-on and tail-end collisions of passenger trains made up of heavy rolling stock.

On the whole, from the standpoint of safety the sooner and the more extensively passenger-car weights are reduced without reduction in the strength of the design, the safer the equipment will become when accidents occur.

Burlington Experience With Zephyr Trains

Many lessons of unusual interest and importance may be learned from the experience of the Chicago, Burlington & Quincy with four Zephyr light-weight, high-speed trains which have accumulated a total of about 1,000,000 miles up to April 30, 1936, according to an article by President Ralph Budd published in a recent issue of Civil Engineering.

Regarding speeds and schedules, President Budd said that the Twin City Zephyrs, operating at maximum speeds of 90 to 95 m.p.h. and at an average speed of 66.3 m.p.h. for the 431 miles between Chicago and St. Paul, Minn. (including six stops), are usually on time. This statement also applies to the Mark Twain Zephyr and to the Zephyr which operates on the Lincoln-Omaha-Kansas City run. In fact, all four trains have made their schedules 94 per cent of the time, which may be compared with 60 per cent for other passenger trains on comparable runs. These other trains, however, have been no more than 30 min. late 90 per cent of the time.

In response to the inquiry regarding any defects or weaknesses which have developed, Mr. Budd said, "No structural weaknesses or defects of any kind have been disclosed upon continuous and careful inspection. Normal maintenance has been followed. For example,

wheels have been changed and turned; pistons have been renewed; fuel injectors have been replaced and somewhat improved. Structurally the cars have proved faultless . . . The availability for service of the four trains has averaged 97 per cent. This high availability is attained by careful inspection and by replacing the parts that wear out on a definite schedule. On our modern high-speed passenger engines, experience has demonstrated the necessity of establishing a mileage limitation on main driver axles. We were of the opinion that this might be found desirable in connection with the motor axles of high-speed Diesel-electrics and we are making periodic examinations of our motor-driven axles."

The four Zephyrs now in regular operation have experienced nine grade crossing accidents, having struck four automobiles, one truck and one road grader, and been run into by two automobiles and one truck. They have run down many animals, including cattle, horses and mules, on the track between crossings. A study of the 10 months' period ending January, 1936, indicates, however, that the Zephyrs had somewhat fewer accidents per million train-miles than other passenger trains. The vehicles struck by Zephyr trains have been demolished or badly damaged, but no damage has been done to the Zephyrs in any of the highway crossing accidents beyond scratching and denting the stainless steel covering, and the trains have always continued on their runs and made scheduled time. In the only accident involving another train, the Mark Twain collided at a speed of about 20 m.p.h. with a string of Pullmans at a cross-over in the St. Louis yards on March 1, 1936. One of the Pullmans was completely derailed and the front trucks of the Zephyr derailed, but it sustained no damage beyond some scratches; none of its 61 passengers was injured, and the train made its regular run the next morning.

As regards safety, Mr. Budd said that the Zephyrs are strong, free from noticeable vibration, have a low center of gravity, hold the rails remarkably well and are easy on the track. The great strength of the stainless steel construction provides a high degree of protection, and he points out that the light weight of the train contributes to safety by permitting relatively short-distance stops to be made from high speeds. It should be pointed out that within the capacity of the brake shoes to dissipate energy without exceeding the break-down temperature of the brake-shoe material, the shortness of the stop is not directly limited by the wheel load.

The patronage of the Zephyrs has exceeded expectations, and, in fact, during last July and August approximately 5,000 persons could not secure accommodations on the Twin Zephyrs, each of which has seats for 70 passengers, plus 15 seats in the dining section, and makes a round-trip daily between Chicago and the Twin Cities. Regarding the cost of operation of the Zephyrs, Mr. Budd said, "The cost of operation for 640,942 miles, up to December 31, 1935 (latest data available), was 31 cents per train-mile. This includes everything except depreciation and track maintenance and includes an accrual for power-plant maintenance. It seems safe to say that the cost of operation is substantially less than half that for a conventional train of the same capacity at the same speeds. Actual costs for the Zephyrs and the best estimate for comparable steam trains are shown in the table:

	Zephyr trains	Steam trains
Maintenance of power plant or locomotive..	$0.0504	$0.1830
Maintenance of train....................	0.0399	0.1020
Cost of fuel oil or coal....................	0.0139	0.1085
Cost of lubricating oil and water..........	0.0093	0.0140
Wages of crew...........................	0.1735	0.2240
Train supplies and expenses..............	0.0271	0.0640
Total	$0.3141	$0.6955

Comparative riding qualities, Mr. Budd says, are difficult to judge, owing to the higher speeds used, but the articulated construction gives certain marked advantages, including the elimination of side motion at the couplings. This feature, together with the low center of gravity, provides smooth and quiet performance at high speeds, especially on curves. The contour of all the wheels, except the power-truck wheels, have been modified so that they now have cylindrical instead of conical treads, and this seems greatly to improve the riding comfort on light-weight trains. On account of the light axle loads, the life of wheels, even at high speeds, has been satisfactory, the average life being 58,844 miles for the 36-in, power-truck wheels, and 56,490 miles for the 30-in. trailing-truck wheels. The efficacy of the cylindrical wheel tread as a means of removing unpleasant lateral oscillations from the riding of the trains has been demonstrated on other light-weight equipment as well as on the Burlington articulated trains.

In regard to the question of whether or not this type of train will take the place of other trains, Mr. Budd said that some additional conventional steam trains will undoubtedly be replaced by relatively small light-weight streamline trains, but the extent of this replacement is uncertain. In the case of small local trains where it is not imperative to interchange cars with other trains or to pick up or set out cars, the maximum economy, comfort and capacity are obtained by light-weight construction, combined with Diesel power. For larger through trains he says that interchangeability of cars is a necessity and some modification of the articulated construction seems essential. The modification suggested by Mr. Budd has already taken tangible form in the two 10-body-unit trains now under construction for the Burlington. Each train will consist of six cars (independent vehicles). The first two will each consist of a single body unit; the next, of three articulated body units; the two following of two articulated body units each, and the last, of a single body unit. Each of the trains will thus have 16 trucks as compared with 11 had it been a completely articulated unit, or with 20 trucks had each body unit been a separate car.

THE READER'S PAGE

British Post Office Tube Railway

TO THE EDITOR:

I quite agree that "Marinac's" cartoons may have considerable attraction for many of your readers. But *where* does he unearth some of the information published in connection with these "Rail Oddities"? Consider, for instance, the one on page 43 of the January *Railway Mechanical Engineer*. In the description on page 44, it is stated that "... the train starts off with its load, which is sometimes as much as 300 tons." In an apparently authoritative article on The Post Office Tube Railway, contributed to an English publication by the engineers of the British Post Office, the trains are said to be composed of two or three vehicles, each carrying a load of 1120 lb., or one-half of an English ton. A descriptive note in "Whitaker's Almanack" for 1927 places the maximum carrying capacity of the railway at "45 tons of mails per hour in each direction". Perhaps 300 tons represents the total amount of mail handled through the subway in the course of an average day.

WM. T. HOECKER.

[Mr. Hoecker's surmise seems to be correct—Editor.]

"Jim Evans" Finds a Backer

TO THE EDITOR:

In the April *Railway Mechanical Engineer* an article appears on the Readers' page signed "A Car Foreman" in which "Walt Wyre" and his "Jim Evans" are taken to task for their apparent mismanagement and poor judgment and control of the roundhouse foreman's job.

After careful perusal of the car foreman's letter it is evident that he has never had any roundhouse experience. There is no comparison between a car job and a locomotive job. To the average locomotive employee a loaded seventy-ton car would be a toy compared to a modern locomotive ready for service and weighing over 400 tons. He says that the "head end" think they are the whole railroad, and goes on to say that the locomotive and crew are just added expense to the road. Let him try throwing the engine out of his automobile. He will eliminate the expense of gas and oil and engine repairs but unless he can coast down hill all the way or use a sail for power he won't get very far.

I did not notice that Jim Evans had done any crying on anyone's shoulder. As the emergencies developed he just put his shoulder to the wheel and kept things rolling along. By the way "A Car Foreman" writes I imagine he holds one of the few snap jobs that may still be left on the railroad. Wait until the efficiency engineers find his hiding place and trim his gang down so that even some of the bone is whittled away.

There is a feeling expressed in his letter which I think has a great deal to do with some railroad inefficiencies today. That is an inter-department rivalry, which is not healthy constructive criticism but more like the opinion of a competitor. Attend a supervisor's meeting and you will soon get the idea. There is a great deal of talk about cooperation between the various departments; you leave the meeting all enthused and start "cooperating," but you soon find yourself on the giving end only. It appears to be a single track with one-way operation only—that is away from you, no returns.

What is needed is a closer relationship between the various departments. Cooperation is O.K., but there are no teeth in this kind of mutual agreement; many men must have a penalty hanging over their heads before they will perform certain classes of duty.

There is much talk and argument regarding railroad consolidation. The railroads as a whole do not need to be consolidated, but as I see it the various departments in each railroad should have a closer coordination with each other. To show what I mean, draw up a chart of the organization of any large railroad system and after completing this family tree, trace back any branch and note how far back you have to go before you reach the connecting link with any other department. It is generally so far away that effective contact to bring about cooperation is out of the question. The supervisor on the job has his feet in the mud while the connecting link at the top of his branch has his head in the clouds.

I would like to congratulate the car foreman on his optimism and good management as expressed in his letter, but would ask him to show a more sympathetic attitude to his brother railroader in the roundhouse. We are both essential cogs in the great railroad machine, and must work together in true harmony in order that railroading may continue to prosper and live up to its traditions.

ROUNDHOUSE FOREMAN.

Spot-Welded Gondola Car

TO THE EDITOR:

With reference to your question following Mr. Havemeyer's letter on page 154 of the *Railway Mechanical Engineer* for April, 1936:

On page 853 of the Railway Review for December 14, 1918, you will find an illustrated description of a spot-welded gondola car built for the C. B. & Q.Railroad, by the American Car and Foundry Company, at St. Louis, in November, 1911. The following paragraph is quoted from the Railway Review article:

"Owing, however, to the inaccessibility of some of the connections and to the use of a considerable number of castings, as in the case of the door hinges, etc., only about 85 per cent of the fabrication was effected by means of the welding machine, rivets being resorted to for the remainder. In the underframe, welding was used on the center sill and cross-brace cover plates, and in the end sill and the body-bolster assemblies. With the exception of the ladder irons, it not being desired to risk human life by attaching them by a process admittedly experimental, the entire superstructure was assembled by the spot welding process."

At the time the article was published, the car had been in every-day service for seven years and was said to have made a very creditable record.

WILLIAM T. HOECKER.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Jim Evans Liked in England

I might add that the stories concerning Evans, the roundhouse foreman are much liked; they make a very good leavening to a thoroughly practical journal.—*From an English correspondent.*

Blowing Down Locomotive Boilers

Railway conditions in England are so different from those in America that the solution of problems in some instances is not necessarily the same in each country, but on other matters an interchange of information is certainly beneficial. Take, for instance, the vexed question of blowdown for locomotive boilers; there is considerable variation in ideas as to whether continuous or intermittent blowdown is best, and as to whether the blowdown should be taken from just below water level or from just above the foundation ring.

Treating 'Em Rough

I heard the following in a certain factory the other day:

"Well! How in ——— did you come to do it, eh?"

"Well, Mr. Smith, it was like this. I thought you said——."

"Thought! You thought? Who the hell pays you for thinking? You're not supposed to think. I'm here to do the thinking. You've made a nice mess of things and I'll attend to you a little later. In the meantime go back to your work."

Then turning to me, he said, "That's the way to tell it to them."

I don't think so. But I wonder if there are any of these foremen left on the railways, who'd tell a man he was not supposed to think. I'm happy to state this was not a big shop, but a so-called high production outfit, and I don't think my foreman friend likes me any more.

Education—Not Repression!

There can be no question that the events of the past seven years have left many railroad men in such a state of mind that some stimulus is needed to lift their vision above and beyond the daily round of humdrum tasks, to inspire clear thinking and to develop a broader viewpoint. Now that we are beginning to emerge into the light again, your unqualified support of the minor mechanical department associations is certainly a well-timed step in the right direction. You are particularly to be commended for openly opposing those who intimate that the members of the smaller associations have sometimes talked too much without being fully conversant with all phases of their subject. Such happenings have been too rare to serve as a pretext for condemning the associations. To be sure, infallibility is not a characteristic of human nature. Occasional inadvertent indiscretions and errors will always be committed, even by those charged with formulating the broader policies of railroading. The remedy for these offenses is education, not repression.

Patent Medicine Stuff

There was a time in the darkest days of the depression when I thought the advertisers were going to have to resort to testimonials and sworn before a notary stuff in order to get the doubtful ones to make a purchase. After all, you know there is nothing like testimonials to sell things—kidney pills, patent medicine or your favorite brand of indispensable cigarettes.

If Mechanical Associations Are Discontinued—What!

If the minor mechanical associations are not to be revived, then something else must be devised to take their place. Railway mechanical engineering is in itself a distinct profession, actively practiced by a large body of able and intelligent men. Under the conditions prevailing in this age, these men cannot remain indefinitely without a forum for the discussion of their problems, the interchange of ideas, and the diffusion of mutual inspiration. Some consideration might be given to the formation of an organization similar in scope to the Institution of Locomotive Engineers, which has attained high prestige in Great Britain and elsewhere. Its meetings are held frequently in various centers, in addition to London. The papers cover the entire range of activities of the mechanical department, and the discussions, stimulated by the circulation of advance copies of the papers, are every bit as valuable as the papers themselves. There are several grades of membership, embracing all occupations from apprentice to chief mechanical engineer.

* * *

For explanation see page 224

With the Car Foremen and Inspectors

Upholstery Work at Beech Grove Shops

A large volume of more or less routine operations in cleaning, repairing and rebuilding passenger car seats, as well as making new seats, is completed annually in the upholstery department of the Big Four passenger-car shops at Beech Grove, Ind.

This department, located on the second floor of the mill-room building, is spacious, well lighted and equipped to produce an unusually satisfactory output, both from the standpoint of quantity and quality. Contrary to usual practice, the efficient line-up of tanks, drainboards and scrubbing equipment for cleaning the seats is located in one end of the upholstery department itself. In addition, this department has been provided recently with a modern hair-picking machine which can be operated without producing objectionable dust, owing to an effective exhaust hood and pipe installation. All of the operations in connection with the reconditioning of passenger-car seats, with the exception of air blowing, are thus concentrated in a single room where they can be more readily supervised and the labor of handling minimized.

Cleaning Cushions

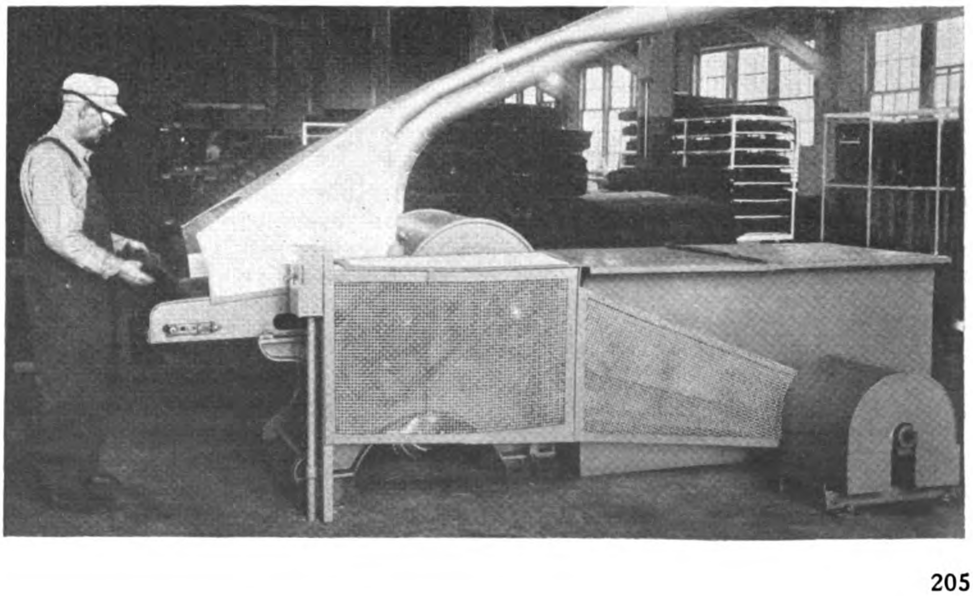
After being removed from cars in the coach shop, seat cushions and backs are piled on trailer trucks and taken to the large wood dusting-table, just outside of the mill-room building, where as much dust and dirt as possible are blown out, using a hose and straight pipe nozzle, with air at the shop-line pressure. Still carried on the trailer trucks, the seat and back cushions are moved into the shop and up the elevator to the cleaning position in the upholstery department. Here they follow practically a straight-line movement. They are dipped in a cleaning solution, placed on a drainboard for a few minutes, passed through a rotary brushing machine, dipped in a dyeing solution if necessary, again placed on a drainboard and finally are loaded in a special cushion wagon for movement to the dry room.

The cleaning solution is a mixture of about 1½ pt. of renovating cleaner to 40 gal. of lukewarm water. The rotary swing-type brush, belt-driven from an overhead electric motor, is used to make several passes over the cushion and spin out all oil, dirt, soot and grease. The dye tank is filled with 30 gal. of water and slightly over a quart of dyeing solution. This solution is brought to a boil and allowed to simmer while the cushions are being dipped. Both the cleaning and dyeing tanks are metal lined and the metal-covered drainboards are arranged to drain back into their respective tanks.

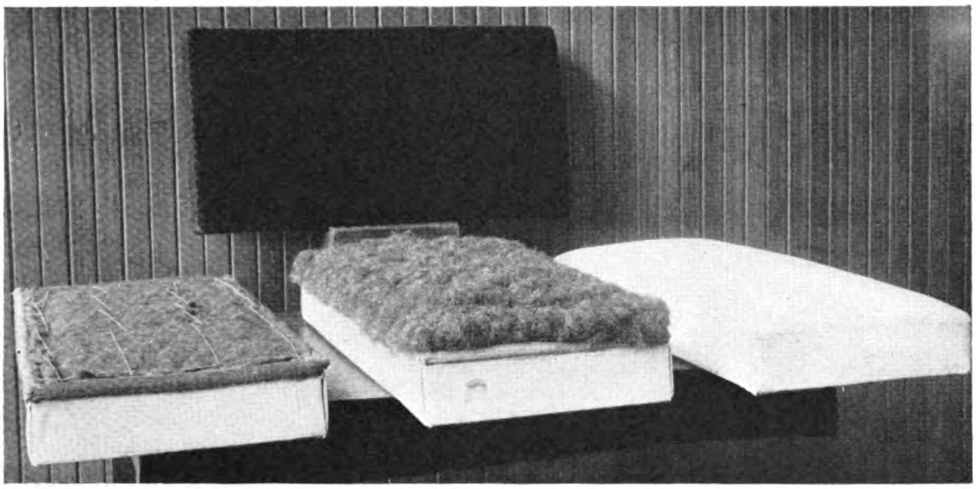
The dry room, into which the cushions are moved on the special wagon, is heated by steam pipes in the usual manner and insulated with ¼-in. sheet asbestos in the sides and 6 in. of plastic asbestos in the roof. With a temperature of about 200 deg. F. in this dry room, the cushions are thoroughly dried in from two to three hours. Using the method and equipment described, one man can clean approximately 1½ car sets, or 63 seat cushions and 63 backs in eight hours.

The Upholstery Shop Facilities

The steel cushion and back wagons used in the Beech Grove upholstery department are a comparatively new design. The back wagon, shown at the left in one of the illustrations, consists of a welded steel frame 87 in. long by 39 in. wide by 60 in. high, supported on 11-in. ball-bearing wheels, two of which are mounted on an axle arranged to swivel under the pull of the handle used in steering the wagon. The bottom frame of this wagon consists of 2½-in. by 3-in. angles, the upper frame being made of 1¼-in. angles, with intermediate angles dividing the wagon into six sections. The seat backs rest on pan sections 4 in. wide with ½ in. upward-extending flanges. These pans are welded to the lower



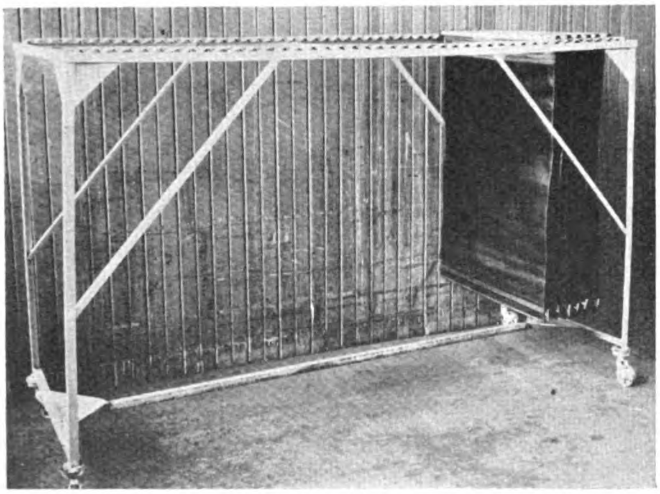
The rotary-type hair picker is provided with an effective dust exhaust system and with a well guarded motor belt drive



Passenger seat cushions in various stages of repair and rebuilding

and intermediate horizontal angles. The backs are held in a vertical position by intermediate horizontal metal strips at each section. The total capacity of each wagon is 20 seat backs.

The cushion wagon, shown at the right in the illustration, is similarly made of a welded steel frame 110 in. long by 39 in. wide by 60 in. high. This frame is divided into three vertical sections, the two outer ones holding 16 seats apiece and the center section 8, or a total of 40 cushions. Each of these cushions rests on a pressed 1½-in. by ½-in. angle, made of No. 14 gage steel, welded



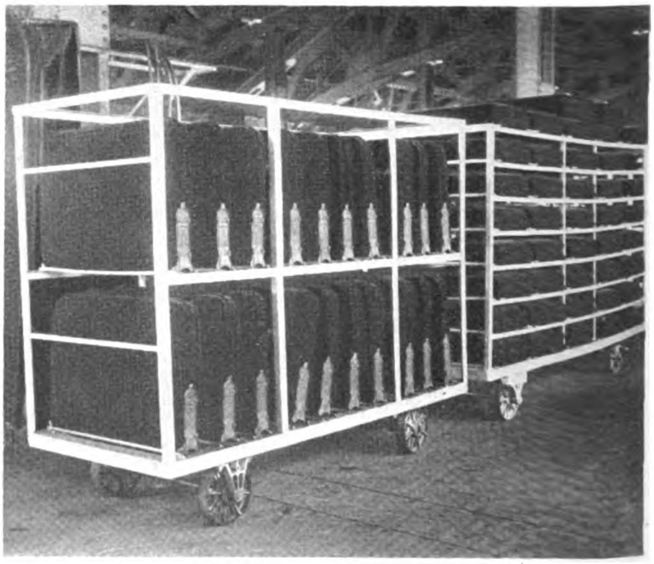
Light and easily portable curtain rack, comprising a welded steel frame mounted on four ball-bearing swivel castors

in a crosswise position and spaced 19 in. apart to accommodate the standard cushion width. Cushions and seat backs are kept in these wagons during their entire handling in and about the upholstery shop.

Still another convenient material-handling device, used at the Beech Grove upholstery shop, is the portable curtain rack shown in another illustration. This consists of a welded steel frame 79 in. long by 29 in. wide by 44 in. high, supported on four 3-in. ball-bearing casters, each of which swivels to permit ready movement of the rack in any direction. The steel frame is made of 1-in. angles welded together and stiffened at the corners by triangular gussets. In addition, four diagonal braces, made of ¾-in. angles, are welded at an angle of 45 deg. between the corner posts and the upper horizontal members to give additional stiffness to the frame. Two steel strips, made of No. 10 gage material and provided with 42 corrugations per strip, are welded to the upper horizontal members. The curtain rollers are dropped into these corrugations and held in place against endwise movement by a wire arc welded along the top of each strip and spaced slightly wider than the length of curtain rollers.

The hair-picker has been equipped with a special electric motor drive and dust exhaust system. Hair, tow or moss are fed into this machine by hand. An endless belt, 24 in. wide, conveys the hair to a pair of special rolls which pass the hair slowly into the machine proper, where a rapidly revolving 22-in. cylinder picks the hair apart, loosens any bunches and produces a uniformly light mass of hair. A perforated metal plate under the picker cylinder serves to screen out any heavy dirt particles which fall on it, but the most of the light dust and dirt are drawn out of the machine by means of the exhaust system.

The hair passes on through the picker into a metal box



Light but strong welded steel wagons used in handling seat backs (left) and cushions (right) in the upholstery department

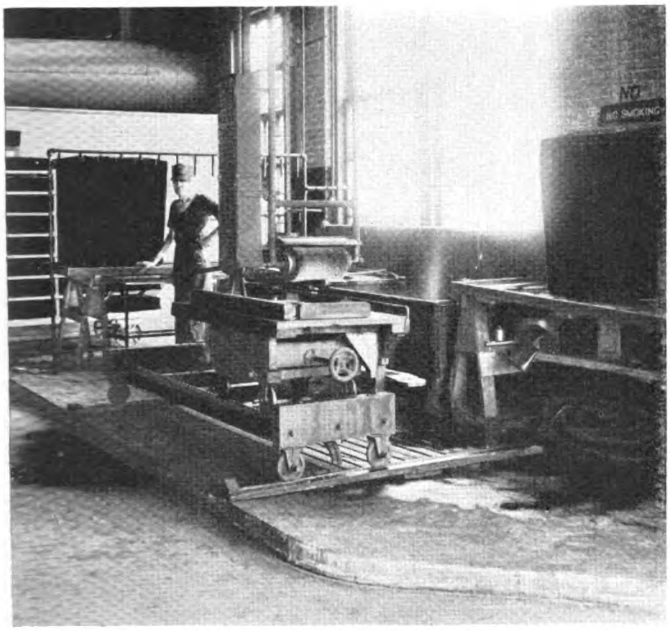
72 in. by 30 in. by 36 in. equipped with a wire mesh in the bottom, which also is used to screen out any small amount of remaining dirt which settles to the bottom of the hair storage box. The easily removable top cover gives access to this box, from which the hair can be supplied to the upholsterers as required.

A feature of this machine is the exhaust system, by means of which a 6-in. pipe draws dust out of the picker

cylinder housing. A sheet metal hood and 3-in. pipe connection to the exhaust system disposes of any dust occasioned by placing the hair on the endless belt at the receiving end of the machine. The machine is driven by a 5-hp. electric motor, with belt drive to the picker cylinder pulley. A neat sheet-metal guard is placed around the motor and a heavy wire screen guard around the driving belt and pulleys.

Method of Handling Cushion Repairs

After being thoroughly cleaned and dried, the seat cushions and backs are moved on the special wagons into



Swing-type rotary brush, tanks and drainboards used in washing car seat cushions and backs

the upholstery department proper, where further careful inspection and repairs are made. On heavy repairs, the seat cover is removed and the cushion dismantled as much as necessary to get down to defective parts, which are either repaired or renewed. Complete rebuilding of the cushion, not normally required until after 10 to 12 years of service, consists of checking the condition and position of springs in the steel frame, application of spring-steel strips on top of the springs, and application of canvas strips over these steel strips to protect the spring canvas, which is glued to the frame at the edges and tacked at the bottom. A canvas-covered hair-felt roll is next applied, with about $1\frac{1}{2}$ lb. of hair per cushion on top; this is held in place by muslin tacked to the wood tacking strips. The cover of plush or other material, with the corners sewed beforehand, is applied over the cushion and tacked in place at the bottom. A seat cushion in various stages of repair is shown in one of the illustrations.

In many cases light repairs only are necessary, such as sewing up a few small holes, applying missing tacks, etc. For intermediate repairs, whenever the canvas cover is cut, liners are put underneath and the ends glued to the old canvas, thus avoiding the complete stripping of the cushion and renewing of the entire canvas. A great saving in time and labor as well as material is effected by this means.

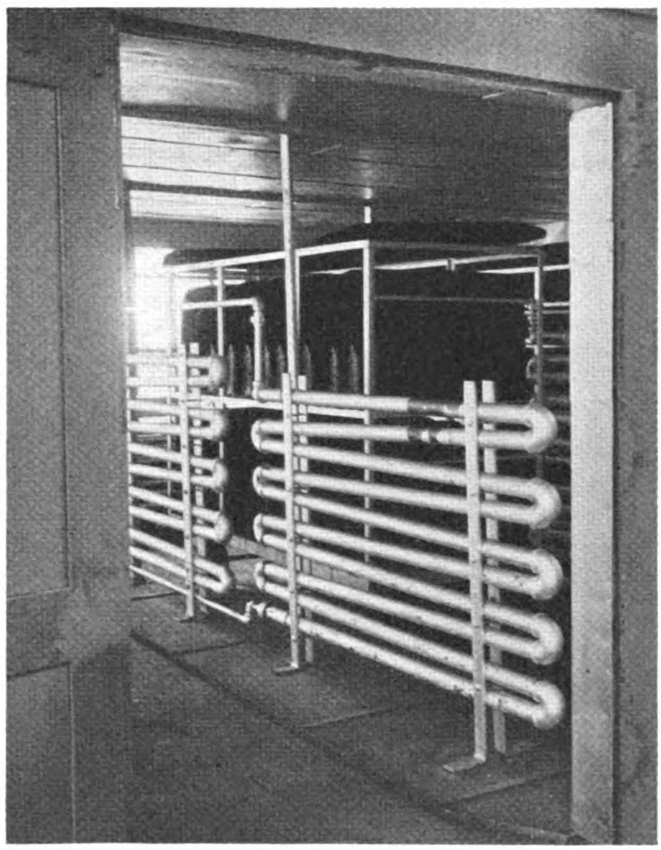
In cases where the plush is badly worn, both it and the muslin are removed and additional hair applied. The muslin is put on again if in good condition and a new cover applied. When the cushions are worn on the ends, the covers are removed and new side strips sewed in place to cover this defect.

In repairing the seat backs, the moldings, made of $\frac{5}{8}$-in. reed, covered with plush, are renewed when worn out. If the back plush is badly worn, it is removed and new covers are prepared for application. If the canvas is torn, the backs are completely stripped down and rebuilt, as liners cannot be applied. Approximately $2\frac{1}{2}$ lb. of hair per back are required in rebuilt car-seat backs.

Curtain and Carpet Repairs

The operations in reconditioning passenger-car window curtains are as follows: The curtains are brought to the upholstery department and the shoes and cover plates removed. The fabric then is washed with a hand brush and soap and the curtains dried on the special wagon previously described. After being removed from the dry room, curtains are equipped with thoroughly cleaned and rebronzed cover plates and shoes. In case curtain fabric needs renewal or sewing, it is taken off and either new curtain material or material that has been repaired is used in refitting the cars.

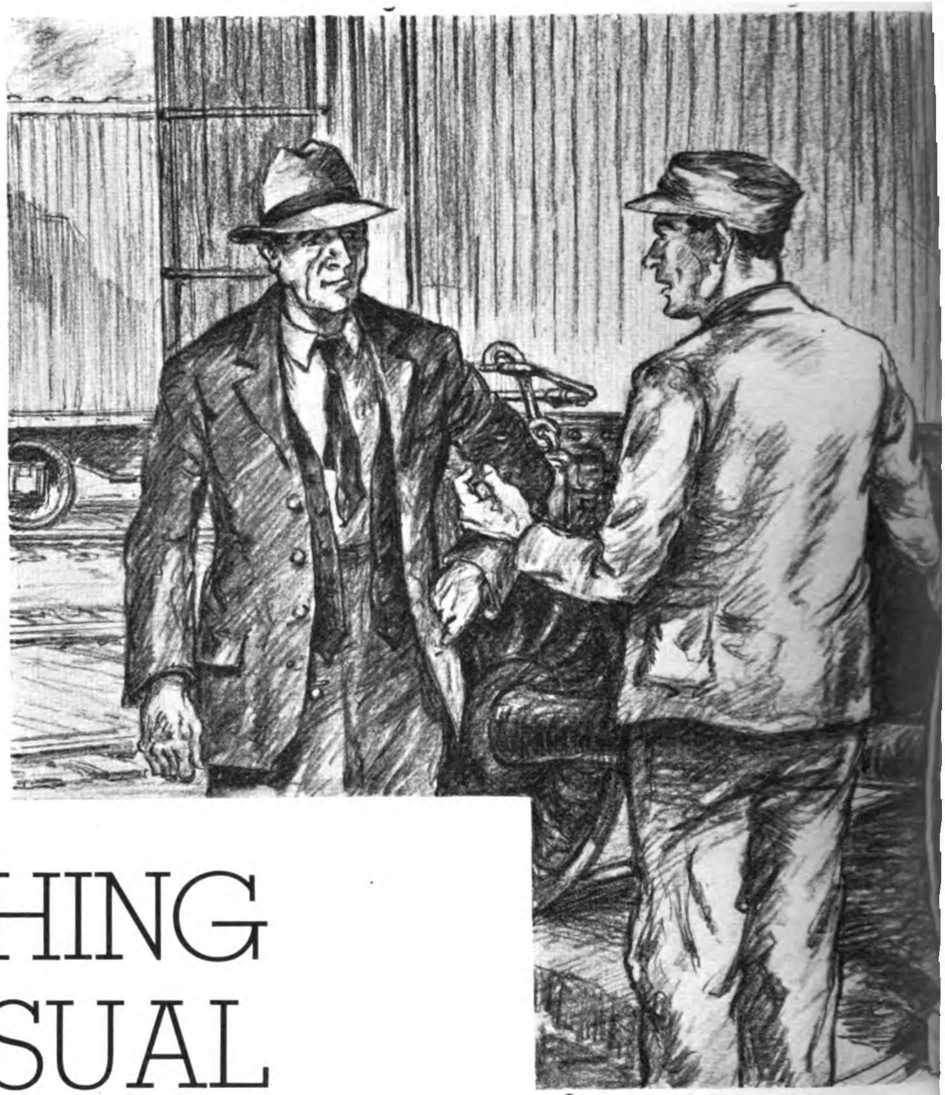
Carpets usually require renewal at intervals of about 18 months. If to be reapplied, each carpet is dusted and washed, using a soap-powder solution which is subsequently sponged off with clear water on the wood bench



Steam-heated dry room, with insulated sides and roof and angle-section floor tracks to guide the wheels of cushion or back wagons

outside the shop building. The carpet is sewed and stretched on the usual type of carpet rack.

Additional work handled at the Beech Grove upholstery shop includes the manufacture of large quantities of locomotive cab curtains, arm rests, seat cushions and backs. Diner and lounge chairs are repaired and rebuilt at another shop, but Beech Grove handles a considerable amount of miscellaneous work such as repairing mail bags, patching diaphragms, etc.



"**Whoever** invented arch-bar **trucks** ought to build **one more** contraption, **then quit,**" Jake growled

NOTHING UNUSUAL

THE car department of the S. P. & W. at Plainville is not the largest on the system by any means, but when it comes to getting trains over the road, it's mighty important. Most of the business is gold ball through stuff that has to keep moving—fruit and vegetables from California and Arizona, cattle and sheep from Texas, New Mexico, and Arizona, with a potential damage claim riding the waybill of every car of stock or perishables that passes through Plainville.

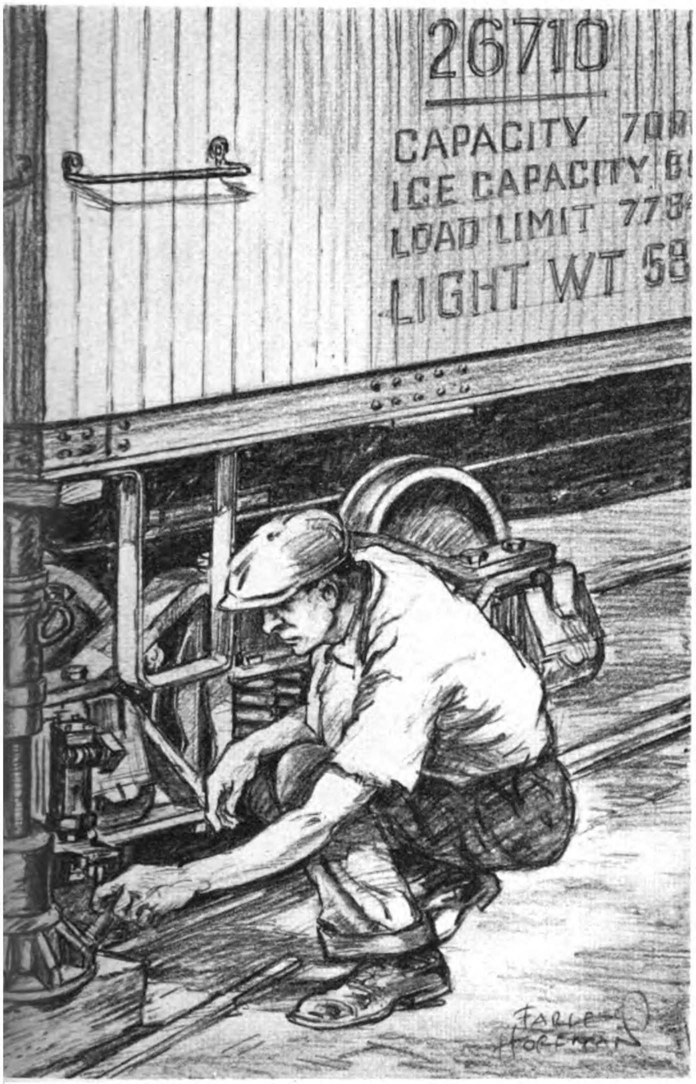
A large portion of the cattle is interchange from the C. T. & W. that crosses the S. P. & W. at Plainville. The C. T. & W., officially Colorado, Texas, and Western but usually referred to by S. P. & W. men as the Count Ties and Walk, runs right through the middle of the "dust bowl area." Any car inspector that has tried to inspect one side of a ninety-car train during one of the sand storms won't wonder why newspaper men have named that district the dust bowl area. At times the dust is so dense that it is impossible to see a lantern two car lengths away. Dust gets in everything. Dick Wheeler, the car foreman, says dust even gets inside the light bulbs at times. Perhaps that is a slight exaggeration, but it does get in journal boxes. Sand mixed with car oil makes a better abrasive than lubricant.

Most of the cars that come in from the C. T. & W. usually have plenty of sand in the boxes and are plenty hot. It's no fault of the "Count Ties & Walk." Some of the cars set out by a stock pen remain days at a time waiting for a rancher to make up his mind to ship. The stock pens as a rule are located on the open prairie with nothing to stop the sand until the cars are set out. It is not unusual for the local crew to have to shovel sand off the rails and from around the trucks before a car can be moved without getting on the ground. Some of the dirt gets in the boxes.

After the rancher makes up his mind to ship, then he gets in a hurry. Soon as the cattle are loaded he sits down by the telephone and doesn't leave it until the cattle are safely delivered at Kansas City; and does he howl if there's a delay!

Besides the perishables and cattle, the S. P. & W. handles quite a bit of oil from the branch line that taps the mid-continent oil field. Pipe lines are taking most of the business from the big companies, but most of the small independent companies ship by rail, usually not enough at the time to make a train, just half a dozen or so cars; but one car limits train speed and makes it necessary to cut down on time spent in the terminal if trains are to make schedules promised shippers and avoid damage claims.

That's the freight business at Plainville, the stuff that pays the bills and keeps men on the payroll. The pas-



by Walt Wyre

senger business is right down the same alley, high-ball stuff everybody hears about if there's a delay—two through trains each way running on schedules that don't allow a minute's lost time to be regained.

DICK WHEELER, the car foreman, looked through the morning mail, laid aside letters to be answered, read the lineup, and strolled down to the car shed to see how things were getting along. He found Jake Miller, a carman, swearing and sweating because a jack he was using wouldn't work. Jake and his helper were working on a "reefer" loaded with lettuce—broken arch bar.

"How you getting along, Jake?" Dick asked.

"Not worth a damn!" Jake glared at the defective jack. "Why can't we get some jacks, anyway?"

"We've got some ordered, had them ordered three months. Four have been sent in for repairs and haven't got them back yet. I'll rush them on 'em."

"Whoever invented arch-bar trucks ought to build one more contraption, then quit," Jake growled.

"Well, we ought to be pretty well rid of them in a couple more years," Wheeler told him. "I'll send Tom Blake over to help you. We have to get this car on 82, you know," he added.

Dick walked on through the shed. The switch engine was shoving in three tank cars, each bore a bad-order card; steam coils leaking on two of them. That meant steaming out the interior of the tanks before it would be safe for a man to work in them. Take a man all day to do it. Wheeler swore softly. He took a turn through the rip and back to the office. Before he got there he heard the phone ringing insistently.

"Hello.... Yes, this is Wheeler," he answered it.

It was the trainmaster on the other end of the line. "Been trying to get you thirty minutes," he said peevishly. "We've got ten cars of cattle coming in from the C. T. 'bout 2:30; want to get them on 82."

"Eighty-two is doped to run at 3:15," Wheeler reminded him, "and No. 10 will be in at 2:50 and we only have two inspectors on duty."

"Well, I want to get those cattle on 82 and there must not be any delay. There'll be five cars of oil on the train. That'll hold him to a forty mile limit to Sanford; they'll set out there. But it'll push them to make connection in K. C."

"O.K., we'll try to get them," Dick told him and hung up.

The car foreman sat down at his battered desk and started to make out his reports. Just as he was all set the laborer that carried material came in.

"Say, Mr. Wheeler, the storekeeper said he needed some help to load a car of wheels and he'd like to get them blocked soon as they're loaded," the material carrier said.

"All right, tell Thompson and Horton to give him a hand. Tell him to let me know when he's ready to block them; I'll try to find a carman to do it, but I don't know where." Wheeler went back to his office work.

Things went along fairly quiet until noon and he managed to get most of his reports made out, together with writing requisitions for material, answering the phone, deciding whether a pair of slid flat wheels on a foreign car should be changed out or allowed to go and a dozen other interruptions.

WHEN Wheeler returned from lunch there was a bluish haze in the northeast, a low lying bank that in most places would have meant rain, but not in Plainville—in March. It meant sand.

"Hope it don't hit here." He spoke aloud to assure himself that it wouldn't, but without success. After the one o'clock whistle blew Dick made a tour of the rip track to see how everything was going. He found all the men working and on hot jobs, none that could be held a minute longer than necessary without explanations being in order. While he was on the rip, the messenger from the office came by and handed him a message from the superintendent. "Beginning March 16th, will want four cars for loading carbon black each day until further notice," the message said.

Wheeler read the message the second time and reached

up and pulled the lobe of his right ear. It was a habit of his when annoyed to pull his right ear.

Carbon black is just about the most aggravating lading that ever vexed a carman —finer than flour, more crawly than wheat, and light enough that it won't settle. Carbon black is really just soot made by burning natural gas with very little air. Wheeler didn't know how he was going to be able to get four cars a day ready without putting on extra men, but it had to be done. About as much chance of getting extra men as a jack-rabbit would have in a dog kennel. Wheeler gave his right ear another tug and went back towards the office.

By the time he reached the office, the bank in the northeast had become a well defined cloud, black and menacing. The air was still, so still that there didn't seem to be enough to breathe. English sparrows were twittering uneasily around the eaves of the office looking for a hiding place.

Wheeler went in the office and picked up the telephone. He called two inspectors that were due to go to work at four o'clock. It meant overtime to explain, but that was better than delays.

THE sand storm and 82 reached Plainville at about the same time, 2:15, and it was hard to tell which whistled the loudest, the engine on the freight or the swooping wind. Dick adjusted a dust mask over his mouth and nose, put on a pair of goggles, and headed out in the sand storm. Facing the wind, he leaned forward so far that if it had stopped blowing suddenly he would have fallen. The sun was completely hidden by the impenetrable mass.

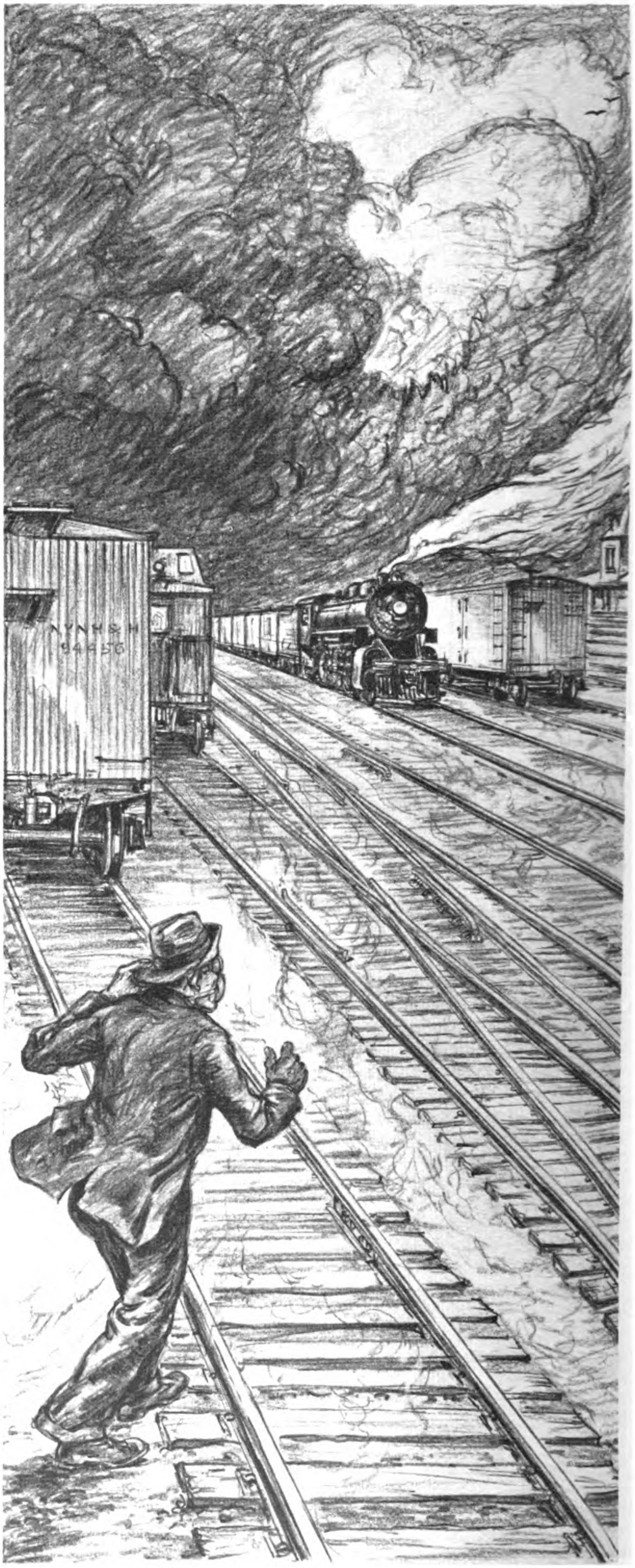
The two first-shift inspectors had already started inspecting the train of reefers when Dick got there. About every fourth car had arch-bar trucks. He hoped there were none broken, and if there were, he hoped the inspectors would find them. They were doing their best, inspecting every one, using flashlight and mirror to inspect the inside.

"Don't seem like that soil-erosion bunch are having much luck stopping the sand blowing," one of the inspectors remarked.

"Wait till they get them shelter-belt trees planted; that'll stop it," the other inspector said sarcastically.

"I've called the two second-trick inspectors. They'll get the passenger. Look 'em over good. Soon as you finish, get that bunch of stock cars. They ought to be in any time now," Dick said and started towards the passenger station.

He met the two second shift men down by the shack. The three of them went to the station. When Dick came down from the dispatcher's office where he went to inquire about No. 10, the switch engine



The sand storm and 82 reached Plainville at about the same time

was coming in on the wye with the cattle cars. He knew by smell and sound, for it was impossible to see that far. The screech of flanges against the rail reached his ears followed closely by the acrid odor of burning dope that assailed his nostrils.

Dick looked at his watch. Two-forty; just fifteen minutes until the passenger would be due. He jerked his right ear and headed back to the rip like a schoolboy going to the circus. The wind was with him and he made good time.

"Get a couple of buckets of dope and beat it down to the east end of number three track," he told a helper. "Bring along a can of oil, too. Tell Morris to come along with you and give you a hand," he added mentioning another helper.

No. 10 rolled in five minutes late. If it hadn't been late, it would have beat Dick to the station. He was puffing almost as hard as the locomotive when he got there. The trainmaster, watch in hand, was backed up against the wall of the passenger station. The inspectors started at the head end of the train. By the time the engine was uncoupled they had the blue flag out and were looking the train over.

In the meantime the wind was doing its best to move all unattached real estate to the southwest part of the country. Passengers peered anxiously through semi-opaque windows and squirmed uneasily in their seats at what they felt to be an unnecessary delay.

"What you think about this brake hanger?" one of the inspectors called out to the car foreman.

Wheeler didn't hear him but understood his gestures. He rushed over to look at it. Pins were badly worn and cotter keys didn't look any too good, worn and loose in the holes. "Give me some cotter keys and go ahead. I'll get it," the foreman told him.

He knocked the cotters out. They were worn almost through. If the inspector hadn't noticed it, chances are vibration would have finished the job before the car reached the end of the run 1,500 miles away. If the key sheared, the pin was certain to work out and let the brake beam drop down. Lesser things have derailed passenger trains and the passengers thought the time used to inspect the train to insure their safety an unnecessary nuisance.

Wheeler put in new cotters and spread the points. "About ready to go?" the conductor asked as Dick came out from under the car.

"Not quite; soon as the inspectors get around."

"Well, we're due out now," the conductor reminded him a little impatiently. "And by the way, the lights don't burn in the lounge car."

"Why didn't you wire ahead so we could have the electrician meet the train?" Wheeler asked the conductor.

"Oh, never thought of it. Just thought is was some little thing you could fix without much trouble."

It so happened the inspectors had already found the trouble with the lights; the generator belt was missing. Dick told them to let it go. He put a train-line connector on and made a note to wire the next division point so they could be prepared to put on a belt.

No. 10 pulled out five minutes later than it was when it came in. If it had been delayed ten minutes, the trainmaster would have had St. Vitus dance from the way he was jerking around.

When the engineer blew his whistle in response to the inspector's signal to release the air, Wheeler started over to number three track to see how things were getting along on the stock cars. They weren't getting along so good. There wasn't a cool box on them. Two new brasses had to be put in, half a dozen had to be repacked. The rest could be made to run by stirring up the packing and adding a little oil. At least Wheeler hoped they could; he was taking the inspector's word for it.

They had finished looking over the cars and were at work getting them ready to go. The helpers had brought brasses and jacks and had one of the jacks in place. The rest of the train was made up and waiting. The switch engine was on the spot nearby panting impatiently. The yardmaster and switch crew crouched on the lee side of the engine waiting for the carmen to finish. When Wheeler gave them the high sign, they climbed leisurely on the engine as though they had all the time in the world. The delay, if any, would be charged to the car department, so why should they worry. At that, 82 got out less than fifteen minutes late on the call and made the run without a car having to be set out on account of a hot box.

A westbound drag pulled in before they finished with the cattle cars. The inspectors would have plenty to do. The car foreman told the helpers to look after the tools and he went back to the rip to figure out how he could manage to get four carbon black cars a day.

At five o'clock the carmen on the repair track went home. Wheeler had some letters to answer and reports to get out. It was after six when he finished. The sand storm passed over and the air was fairly calm when he reached home.

"How did things go today?" Mrs. Wheeler asked her usual question.

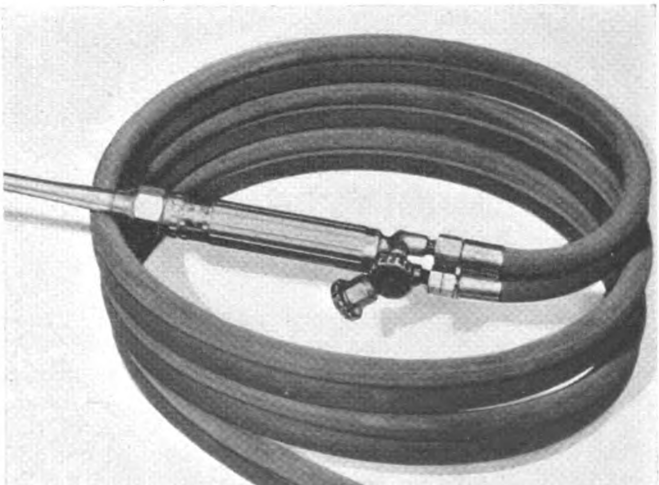
"Oh, 'bout as usual, kinda busy," Dick replied.

"Well, if you had to keep house with all these sand storms, you wouldn't be so calm about it," his wife said.

"Yeah, must be pretty bad," Dick agreed.

Duplex Hose for Gas Welding

A type of rubber tubing or hose of unique construction has been developed by the Electric Hose and Rubber Company, Wilmington, Del. It is especially designed for gas welding and cutting equipment and similar services. In its construction twin hose are simultaneously molded with a connecting web between them, so that a cross-section resembles the figure 8. A single length of this non-kinking hose is all that is necessary for equip-



"Supero Siameez" duplex hose for gas welding work

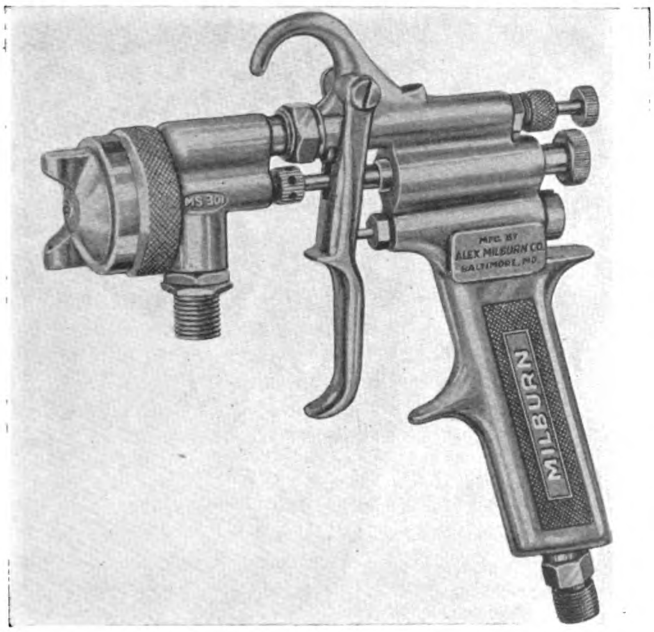
ment which heretofore has required two separate lengths. This hose is of "Supero" construction, with a special cord-wound reinforcement between the first and second braid, giving it a much higher bursting limit than ordinary welding tubing—with the ¼-in. size the bursting pressure is 2,000 lb. per sq. in. This construction permits the use of differing pressures in the two sides without torque or writhing.

"Supero Siameez" hose is made with the individual conduits in different colors—red and black or red and green, for example—or with both the same color. The connecting web may be easily cut down with a carborundum wheel the distance required for attaching the hose to separate outlets.

New Type Paint Spray Gun

The Paint Spray Equipment Division of the Alexander Milburn Company, 1436 W. Baltimore St., Baltimore, Md., has announced a new paint spray gun, known as Type MM. This gun is so balanced that it is easy to shoot a smooth, even spray exactly where wanted. Coverage and shape are controlled by merely turning two simple knurled nuts.

Cleaning is a matter of a few seconds only as every part touched by the paint is in the single-unit detachable spray head which is made of drop forged bronze. The gun handle and body are one piece, die cast aluminum



Milburn Type MM paint spray gun

alloy. A standard air hose connection, located at the base of the handle, is designed for ease of handling and to prevent tangling of the hose or obstructing adjustment controls.

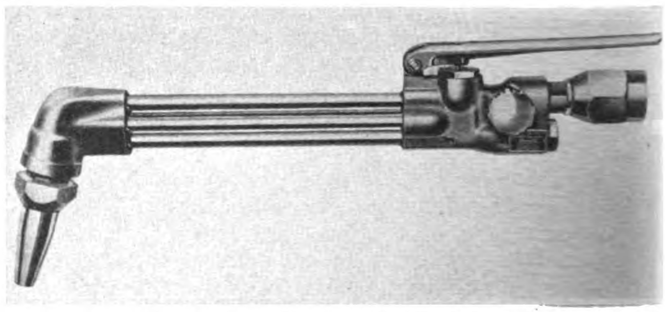
The two-finger grip trigger conforms to the shape of the fingers, responding to the slightest touch. A knurled adjusting nut operates a non-corrosive needle valve to regulate the air flow to the atomizer head. This controls the spray volume and the shape of the spray, whether flat or round. Another knurled nut adjusts the fluid flow by means of a stainless steel needle valve. This valve is connected by a universal joint for constant alignment and easy replacement of paint needle valve points. The valve is closed by a tension spring.

Fluid and air control valves are set so that when the trigger is pulled, air is first admitted into the spray head, then the fluid; when trigger is released the fluid needle valve closes first, then the air valve. This prevents weeping or spattering when the fluid is turned on. The fluid connection is conveniently located beneath and is a part of the detachable spray head.

The Milburn Type MM spray gun is satisfactory for either siphon or force feed and utilizes all types of spraying materials, including synthetics and emulsions. It is recommended for work where wide, perfectly atomized spray and large capacity is required.

Oxyacetylene Cutting Attachment

An oxyacetylene cutting attachment, known as the Oxweld Type CW-22, has been announced by the Linde Air Products Company, 30 East Forty-second street, New York, N. Y. This cutting attachment incorporates features of design and possesses a range of performance which permit it to handle light sheet metal as well as all but the heaviest work at speeds equal to those of the full-size cutting blowpipe. The Type CW-22 attachment operates on either low-pressure or medium-pressure



Oxweld Type CW-22 cutting attachment

acetylene and can be used on either the Oxweld Type W-17 or W-22 welding blowpipe handle, thereby extending the utility of these two blowpipes.

Sturdy, smooth operation at all pressures is said to be given by the new streamline injector and by the improved type cutting valve, with removable seat, centralized under the cutting lever. The mixed-gas passage is formed by three Ambrac tubes. The length and the four 90-deg. changes of direction afforded by this type of construction give exceptional flashback resistance. The body and head of the CW-22 attachment are designed to combine strength and lightness. The body is of pressure-forged bronze while the head is a manganese bronze forging.

Brothers' Service Record—The four Urquhart brothers of Roanoke, Va., all employees of the Norfolk & Western, challenge any four brothers on any railroad to beat their service record. The brothers have a combined total service of 175 years. L. H., 66, a gang leader in the Roanoke shops and the oldest of the quartet, started to work for the N. & W. when he was 19. He has a record of 47 years. G. A., 64, a gang leader in the shops, also started to work for the railroad when he was 19. He has a service record of 45 years. L. D., 62, an engine carpenter in the Roanoke shops, likewise entered N. & W. service at 19. He has worked for the railroad 43 years. C. E., 61, a passenger conductor on the Shenandoah division, was 21 when he started to work for the railroad. He has served 40 years. If the four brothers work to the retirement age of 70, they will have served the Norfolk & Western a total of 202 years.

IN THE BACK SHOP AND ENGINEHOUSE

Relining Rod Bearings By Centrifugal Process

*By L. E. Grant**

Failures of the connecting-rod bearings in the engines of the gas-electric cars on the Chicago, Milwaukee, St. Paul & Pacific have been troublesome. This problem became more acute on the Milwaukee several years ago after the cylinders had been increased one-half inch in diameter. The bearings, which are 80-10-10 bronze lined with a high-tin babbitt, could not be increased in size to compensate for the heavier loading. Most of the failures occurred near the center of the top half and were due to the babbitt cracking or chipping out locally in this zone. A few failed due to the babbitt separating from the bronze back, the separation beginning near one edge. The majority of the failures were in bearings relined in the shop but some occurred in new bearings purchased for these engines.

Consideration was given to the idea of having the manufacturer reline the old bearings but this was found to be practically as expensive as buying new ones. Purchasing a new set of bearings every time the engines were overhauled did not appear to be justified; it seemed as though it ought to be possible to devise a satisfactory method of relining these bearings. Some experiments, accordingly, were undertaken to see if this could not be done. These experiments culminated about a year and a half ago in a centrifugal method of relining that has given extremely satisfactory results. A description of the process may be of interest to those faced with a similar problem as the principles can be applied to other bearings.

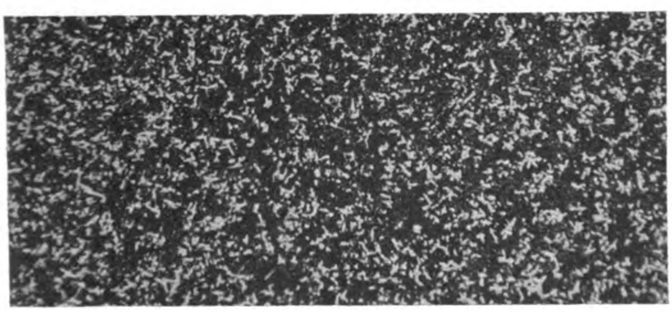


Fig. 1—Microstructure of centrifugally cast babbitt

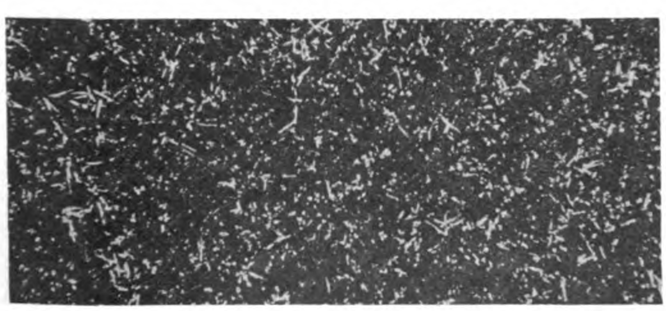


Fig. 2—Babbitt of same composition as Fig. 1 but cast by mandrel process

* Chief Chemist, C. M. St. P. & P.

The centrifugal process of casting babbitt is not new, having been used by engine builders for some time. However, no instance of it having been used in relining bearings has come to the attention of the author. Centrifugal casting offers two advantages: (1) it is a comparatively simple process, and (2) it produces a fine-grained, dense metal possessing good wear resistance. Fig. 1 shows the structure of centrifugally cast babbitt at 100 diameters, while Fig. 2 shows the same metal cast from the same temperature against a mandrel by the old method. It will be seen that in Fig. 1 the white crystals are more numerous and smaller than in Fig. 2. These crystals are hard particles that resist wear and insure long life. The small size and good distribution of these hard crystals produces excellent properties in the metal.

Centrifugal casting is ordinarily applied only to cylindrical or essentially cylindrical objects. In the case of the bearings involved here the problem was complicated by having the cylinder in two parts. It was necessary to join them together in order to cast the babbitt into them. The two halves could not be simply placed together as they do not form a cylinder when this is done on account of the metal that has been cut out to allow for shims. A fixture to hold the two halves of the bearing together, was therefore necessary. Such a fixture was designed and built by the shops. It is shown in Fig. 3. It consists of three pieces. *A* is a solid steel shell, tapered slightly inside, into which the two halves of the bearing are placed. *B* and *B* are two steel blocks to fill the space between the bronze shells and the steel band *A*. They are tapered on the outside to fit the taper of *A*, while on the inside they have the same radius as the back of the bronze shells. They serve to wedge the two halves of the bearing tightly into the steel band. Narrow strips of wood *C* separate the ends of the bearing halves from each other. They are driven in tightly to assist in holding the parts firmly in place in the steel shell and also to close the gap that would otherwise exist between the ends of the bronze backs. These pieces of wood are shellacked thoroughly a day or two before they are to be used.

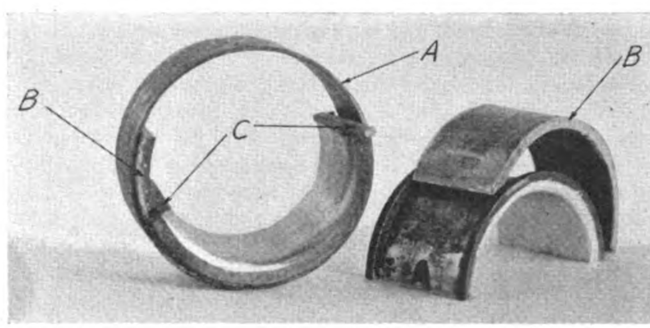


Fig. 3—Assembly of bearing halves

Assembling the various parts in the fixture produces the cylindrical shape that is necessary for this process of relining bearings. The completed assembly is handled as a unit during tinning and lining. Several of these fixtures are used, all of them being set up with the bronze backs before any tinning is done. When the bearings

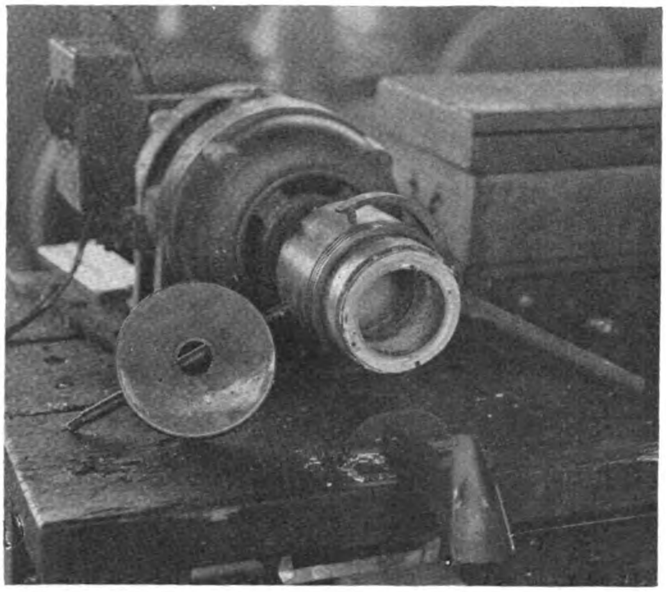


Fig. 4—Fixture for centrifugal casting of connecting-rod bearings

have all been tinned and babbitted they are removed from the fixtures which are then ready for more bearings.

A 1½-hp. three-phase 60-cycle motor, which runs at about 860 r.p.m., when loaded, is used to spin the bearings. A steel drum is mounted directly on one end of the armature shaft to receive the fixture described above, the inside diameter of the drum being just large enough to accommodate it. Fig. 4 gives a good idea of the general arrangement of the various parts. The front of the drum is closed with a screw cap in which there is a hole for pouring the babbitt. A coarse thread is cut in the cap and on the outside of the drum to facilitate rapid tightening.

Once the bearing has been tinned no time must be lost in transferring it to the drum and setting it to spinning or there is danger of the solder freezing before the babbitt can be poured. If this happens the adherence of the babbitt to the bronze is certain to be poor and the bearing will be unsatisfactory. Hence every precaution has been taken to make it possible to carry out quickly all operations subsequent to tinning.

The back wall of the drum serves as a dam for the babbitt on that end while the screw cap closes the other end. Card board washers are used at each end of the bearing to prevent any babbitt from flowing out through any small irregularities and to prevent it sticking to the housing. If this were not done it would be difficult to remove the bearings from the housing after the babbitt had set. When the molten babbitt, at the proper temperature, is poured in it is distributed evenly over the surface of the bearings by centrifugal force.

Preparation of Shells

Proper preparation of the bronze shells prior to soldering was found to be the most important step of the entire operation. Unless the backs are properly cleaned the solder will not adhere as it should and hence the babbitt will not be securely anchored. Early failure of such a bearing can be expected. Several methods of cleaning the old bearings were tried. Sand-blasting and grinding were unsatisfactory. This was probably due to particles being forced into the pores of the bronze with such force that they were not easily removed subsequently.

Machining was satisfactory for cleaning but had the disadvantage that each time a shell was cleaned the thickness of the bronze back was decreased even though only a light cut was taken. Also the thickness of babbitt left after machining to proper size was increased. Neither of these results is desirable. Adequate thickness of the back is necessary for mechanical strength or the bronze is likely to break in service due to the heavy loads. A thick layer of babbitt is undesirable as it is more easily squashed out when thick than when it is kept down to a minimum thickness. Many automotive bearings have babbitt linings only 1/32 in. thick. The Milwaukee Road does not attempt to work to such low limits but an effort is made to keep the babbitt as thin as is practical for the conditions. Most of the linings are between 1/16 in. and 1/8 in. thick.

Fig. 5—Pouring babbitt into the fixture

Hand scraping of the bearings was finally decided upon as the most satisfactory method of preparing the backs for relining. The old babbitt is melted off in a bath of molten scrap babbitt care being taken to shake off all the babbitt possible. When the back is cold the surface is scraped just enough to uncover the bronze. In this way no appreciable metal is removed from the back itself yet a good clean surface is obtained. It is good practice not to do any scraping until just before the bearings are to be relined. If the back stands around the shop after being scraped it becomes dirty again and is difficult to tin properly. Unnecessary handling, especially with greasy hands or gloves, should be avoided or poor adherence is likely to be the result. The newly scraped surface tins without difficulty while dirty bearings are more difficult to tin and may later fail in service even though they appear to tin properly.

The matter of properly preparing the bearings for relining requires and deserves some thought as well as care in the operation. The success or failure of the whole job lies in this step whether the bearings are to be spun in or cast by the usual mandrel method. It may appear that hand scraping is too costly but unless some other satisfactory method is found which is faster and cheaper, the hand method will still be the most economical in the long run. Any method that produces bearings which will not stand up well in service is costly. Delays to trains due to engine failures must be prevented so far as is humanly possible.

Relining of bearings is ordinarily an intermittent job and except in cases of emergency, babbitting is not done until enough bearings are on hand for a days work. The bearings, prepared by scraping as described above and assembled in the fixture, are given a thorough rinse in a hot alkaline cleaner, and then in hot water. This removes any oil and leaves the metal in good condition for fluxing and tinning. If the rinse water is boiling the assembly will dry quickly and no water will be left to cause splashing when the fixture is immersed in the solder. The bearing surface is brushed over with concentrated muriatic acid as a flux and the unit placed in a bath of 50-50 solder maintained at a temperature of 650 deg. F.

The unit is kept in the solder until it reaches the temperature of the bath. Prolonged immersion is avoided because the solder will dissolve the lead in the bronze making the backs brittle and weak. The surplus solder is quickly brushed off the outside with a fiber brush and the fixture inserted into the drum on the motor.

After tightening the face plate the motor is started. Enough babbitt is dipped from the babbitt pot, maintained at 800 deg. F., to fill the bearing. This is poured through the hole in the plate, a hinged trough being used to guide it, see Fig. 5. After spinning about two minutes the babbitt has solidified and the motor is stopped. The unit is then removed. The lined bearings are knocked out and the fixtures used again immediately if sufficient bearings are at hand, as is usually the case.

In the year and a half that this process has been regularly used not one of the bearings has failed so far as is known. None have yet been returned for relining, each one has been marked so that they may be recognized when they do come back. Recently a bearing was inspected after it had been in service more than nine months; (the occasion for this was the failure of a connecting rod) none of the shims had been removed after this period of service and, in spite of the fact that the rod had broken, the bearing was in such good condition that it was returned to service.

The tin-base babbitt used in lining these bearings has the following approximate composition: Tin 89 per cent, copper 3.5 per cent, antimony 7.5 per cent, lead and arsenic, a trace. The Brinell hardness at room temperature is about 25 (10 m.m. ball 500 kg. pressure). It is poured at 800 deg. F. whether it is to be cast by the centrifugal or mandrel process. The same metal is used in lining the main bearings of these engines. Some of the mains are lined centrifugally but not all as the necessary fixtures have not been made for them. Further they give very little trouble. This is good evidence that the chief cause of the trouble in the connecting-rod bearings is the severity of service. Tinning practices that are satisfactory for bearings subjected to normal stresses are not good enough for highly stressed bearings.

Fusion Welding On Boilers and Tanks*

Two committee reports on fusion welding as applied to locomotive boilers and tenders were submitted at the recent convention of the Master Boiler Makers' Association. The first outlined the development of the art up to the present time when practically all fireboxes are built up with fusion-welded butt seams, welding at firedoor holes is almost universal, tubes and flues are generally welded, and the process is being steadily extended. The second report dealt more particularly with details of the application of welding to locomotive boilers and tanks. Brief abstracts follow.

The joining of sheets in locomotive fireboxes by fusion welding has been adopted on practically all railroads. The process most commonly used is the electric arc, while oxy-acetylene is also extensively used. The butt

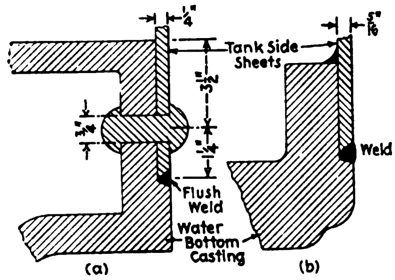


Fig. 1

Welding tender side sheets to water-bottom underframe

weld, with sheets beveled on the fire side, is the recognized and preferred type of joint used. Wherever it is possible, the weld is reinforced on the opposite side of the bevel. In preparing firebox sheets for welding an opening of from 1/8 to 3/16 in. should be allowed between the sheets to obtain the full penetration of the weld. Where the shielded arc electrodes are used, closer fitting is necessary and an opening of 1/16 in. between sheets is sufficient. The bevel on each sheet should not be less than 30 deg.

After clamping the sheets in place they should be tacked at sufficiently close intervals to hold them properly in place while welding. All necessary tacking should be done before the welding is started, to prevent the sheets from being drawn out of line and also to hold a uniform opening between the sheets to secure proper penetration.

In welding locomotive oil tanks and tenders to replace

* Abstracted from two committee reports submitted at the September, 1935, meeting of the Master Boiler Makers' Association. Complete reports with discussion are given in the proceedings published in the October, 1935, issue of the Boiler Maker and Plate Fabricator.

the former practice of riveting, some railroads now use the all-welded type of construction and, up to this time, it has proved satisfactory. Other railroads have resorted to a combination of riveted and welded construction which has also given satisfactory results.

Where cast-steel tender frames of the water-bottom type are used, some railroads are welding the outside plates to the cast-steel underframe, the sheets being welded at the bottom edge to the frame on the outside

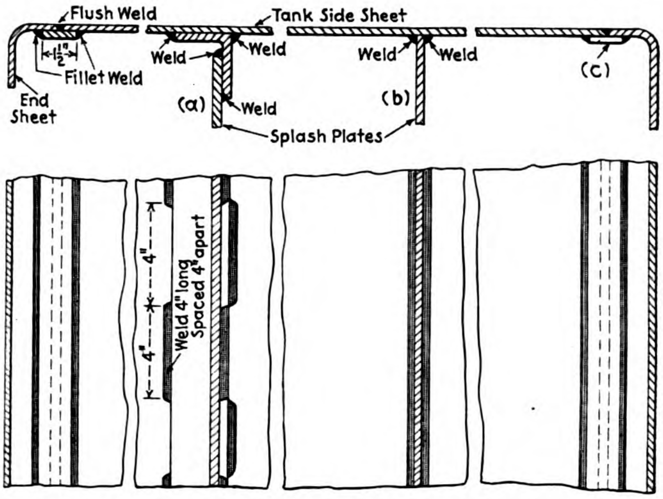


Fig. 2

Details of tender-tank welds

where it laps over the casting. They are also fillet welded to the casting on the inside, thereby eliminating the possibility of water getting between the sheets and casting and starting corrosion, as may be the case if the weld is not made on the water side. This construction also acts as a stiffener to support the sides. See Fig. 1 (b).

Where the combination of welded and riveted construction is used, this same type of welded joint is made,

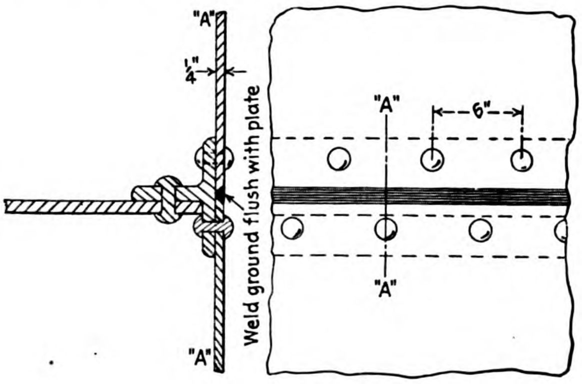


Fig. 3

Welding used in replacing tank side sheets

except that the filet welding on the water side of the tank is omitted and the rivets are spaced above the bottom horizontal wild. See Fig. 1 (a).

Stiffening angles, cross-braces and splash plates are applied in the all-welded construction, as outlined in Fig. 2 (a) and (b), where rivets are entirely eliminated. When judging the stiffening effect of the construction as outlined in Fig. 2 (a) it occurs to your committee that this design is most desirable. There are features in favor of the construction shown in Fig. 2 (b), such as lightness of construction and lower cost of application, which may be preferred in the construction of lighter

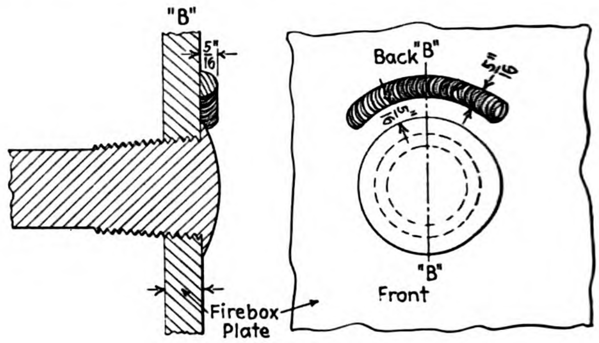


Fig. 4

Welded rib for protecting staybolts

tanks. However, sufficient comparative service has not been rendered for your committee to be justified in making any recommendations as to which type of construction could be recommended as a standard practice.

Fig. 2 (c) shows the type of vertical seam being used in some designs of water-tank cisterns. In this design the welt strap is placed on the water side of the plate, which has a tendency to produce a stiffening effect on the flat vertical sides of the tank plate.

Where repairs are made to the present riveted type of tank construction, there are times when it is necessary to remove large plates, especially in the sides of tank cisterns, in order to repair the defect and maintain their uniform appearance. Before fusion welding was developed large sections were usually riveted in place,

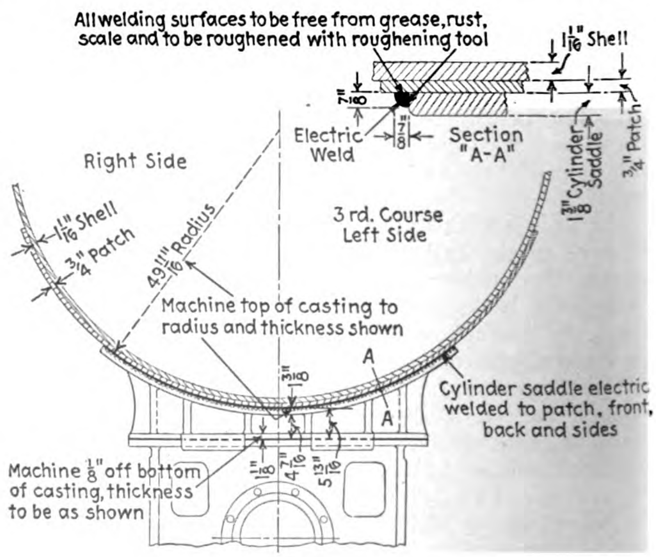


Fig. 5

Welded saddle liner on a single-expansion locomotive

the cost of which was high. The cost of this class of repair has been greatly reduced because smaller sheets are now welded between the horizontal riveted seams of angle or tee braces, as outlined in Fig. 3, following the center line of braces and not changing the appearance of the outer portion of the tank where the section is applied. Some railroads now consider it a standard practice to insert the lower one-third section in this manner as it becomes necessary.

Fig. 4 shows a fusion welded rib which is applied to the fire side of firebox plates where cinder cutting is causing the heads of staybolts to be cut away. These

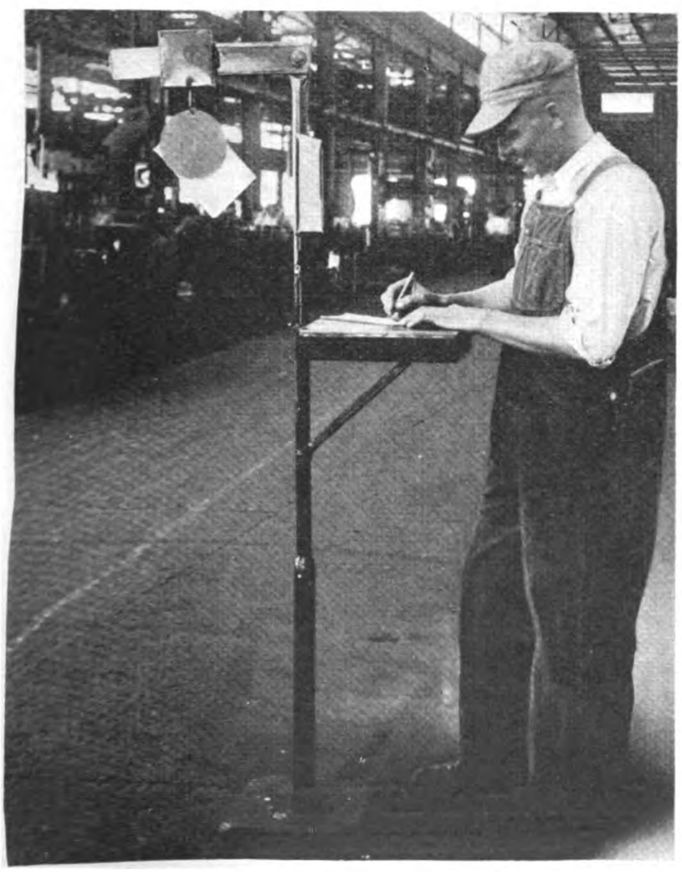
ribs are welded in place while the water is in the boiler and have the effect of minimizing the cinder cutting action on the fire ends of the bolts.

One railroad has a single-expansion articulated type locomotive in service with the No. 2 cylinder saddle and the boiler-bearer castings electrically welded to a liner, Fig. 5, which is riveted to the barrel of the boiler especially for this purpose. This practice eliminates the use of a cylinder saddle and boiler bearer bolts and holes in the barrel of the boiler. Freedom of leakage from these sources is of material advantage. This locomotive has been in service for almost two years. The illustration shows the manner in which the cylinder saddle and bearers are prepared and the method used for welding.

Shop-Material Order and Delivery Stand

The illustration shows a comparatively new type of shop-material order and delivery stand which is being successfully used at the West Burlington (Iowa) shops of the Chicago, Burlington & Quincy. Stands of this type are located throughout the shop for use by gang foremen, store department redcaps or material supply boys and shop tractor operators, who handle all material to and from the shop as well as the inter-shop deliveries.

These stands are 70 in. in height with a steel plate base ½ in. by 12 in. by 12 in. A piece of 2 in. scrap flue, 22 in. in height, is fastened to the base plate, and welded within this flue is a 1¼ in. pipe extending to the top of the stand. To this pipe, approximately half way from the floor, is fastened the desk which is 14 in. by 12 in. by 2½ in., made of No. 16 jacket iron. At the top of the pipe is an arm 13 in. by 3 in. bent to form a guide. A 3-in. plate moves in this guide.



Shop-material order and delivery stand at West Burlington shops

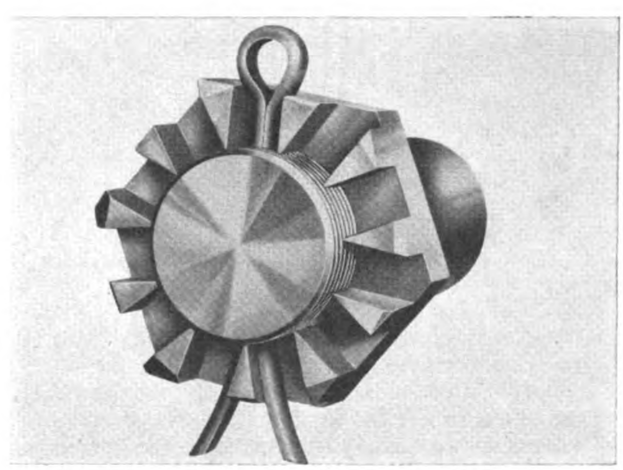
This movable plate is painted on the outside with a 2-in. red and yellow stripe, which permits two different signals; namely, when the entire plate is visible, showing both the red and yellow stripes, the foreman has placed an order on the hook; a redcap picks up the order and pushes the plate in half way so that only the red portion is visible. The plate is entirely pushed in when the order has been filled. A yellow disc 6 in. in diameter is hung on the hook when the foreman desires the service of a shop tractor.

The tin box fastened on the stand serves as a writing table as well as a holder for requisition pads. This eliminates the necessity of gang foremen carrying these requisition pads, the stand being centrally located in each department and immediately accessible.

Orders are hung on the hook at the top of the stand, being gathered as delivery men pass the various stations. All orders are marked to designate the stations to which material should be delivered. A holder on this rack serves in posting the weekly engine report showing the status of all engines in the shop.

Slotted Nut with Closer Adjustments

An improved nut of the Cooke type which offers from 10 to 22 adjustments per turn depending on size, instead of the usual six per turn, is now being marketed by the Blatchford Corporation, 80 E. Jackson Boulevard, Chicago, Ill. On this nut, which is known as the Cooke micro-slotted nut with closer adjustments, the micromatic adjustment is obtained by locating the keying wedges off center from one another so that two keying positions are possible for each slot. At the keying position a wedge centers the hole and if hole



Cooke micro-slotted nut with closer adjustments

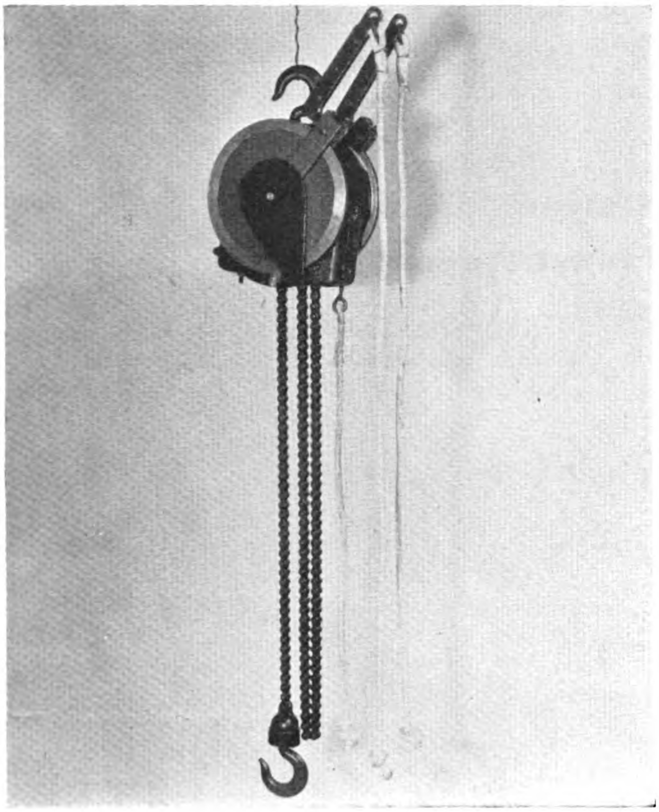
and wedge are not in keying position at the first trial, a slight tightening will bring a wedge into position at one end or the other of the hole, so that the key can be inserted from either end. Because of this closer adjustment—.008 in. to .013 in. depending on size—there never is an occasion for backing off the nut to get a keying position or for tightening with shims.

The key is set by simply tapping it in with a hammer, no pliers being needed. The key spreads automatically, curving outward and filling the space between the wedge

and sides of the hole, firmly locking the bolt, nut, and key. A special key is supplied with each nut. The end of the key is trimmed off to an internal V-shape so that it spreads readily around the keying wedge on the nut, without catching on the wedge. The smoothly curved shape of the key when set gives this nut a neat, workmanlike appearance when installed.

Coffing Gravity Lowering Hoist

The Coffing Hoist Company, Danville, Ill., has recently perfected a type of hoist known as the Challenger, said to be the only spur-gear, twin-power, gravity-lowering chain hoist on the market. As shown in the illustration,



Coffing spur-gear, twin-power, gravity-lowering hoist

this hoist is designed to be operated by rope pull on two levers which have a friction grip on the faces of two disk wheels, thus eliminating entirely the necessity for a hand-chain to lift the load.

The load is lowered by gravity to any position desired, the speed being entirely controlled by a simple governor arrangement. When there is no weight on the hoist, the slack in the load chain can be taken up by pulling on the loose end of the chain, or the chain can be pulled out free for quick adjustment by simply releasing the clutch, which also is rope operated.

The Challenger is said to be fast, efficient and durable in operation. It is provided in four capacities, namely: ¼, ½, 1 and 2 tons. It is fully ball-bearing equipped and designed to operate with safety under 100 per cent overload. In railway shop service, this type of hoist is a great time and labor saver when used for handling heavy parts, such as crossheads, pistons, rods, etc., during the various machining and assembly operations. The gravity-lowering design and free chain for quick adjustment are particularly valuable features.

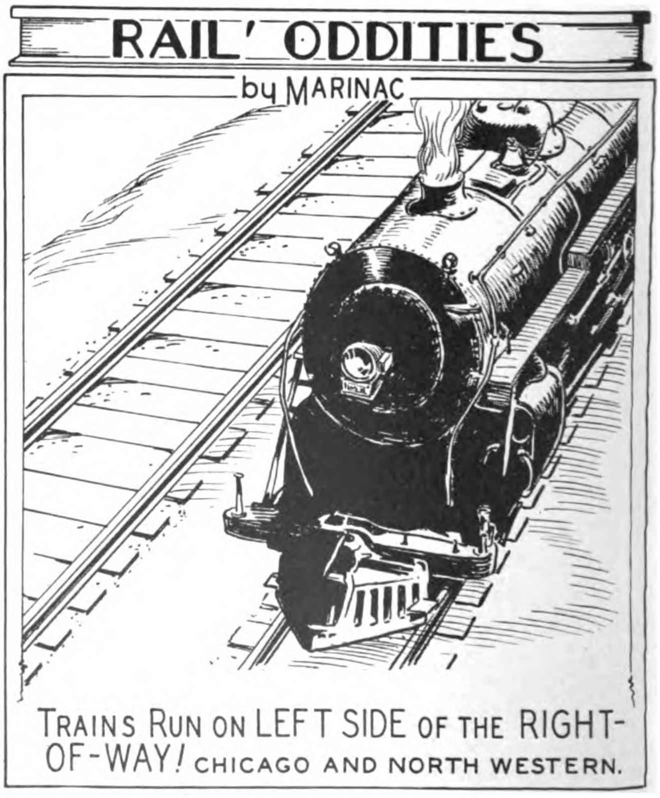
Collapsible Hand Tap

A hand sizing tap of the collapsible type designed primarily to take the place of the solid adjustable taps ordinarily used has been added to the line of machine collapsible taps manufactured by the Landis Machine Company, Waynesboro, Pa. These taps offer the advantage of instant withdrawal from the work without requiring to be backed out. They also eliminate the tearing of threads, frequently caused by backing out a solid tap, as well as undue wear of the chasers by having the radial clearance worn off in the backing-out operation. Tapping time is, of course, saved, thereby increasing production.

A small handle or trigger is located on the side of the tap body for unlatching the tap and collapsing the chasers by pressing back on the handle. The chasers are reset by pressing against a plunger extending slightly beyond the rear of the tap shank. The tap shank is provided with a square end to fit a tap wrench. Any length of shank or tap can be supplied.

The top is provided with a diametrical adjustment of approximately $\frac{1}{32}$ in. both over and under the nominal chaser size, a total of $\frac{1}{16}$ in. The adjusting screw is located in the front end of the tap and is of the ratchet type, making it self-locking to maintain size. A turn of one notch to the adjusting screw gives a diametrical movement of the chasers amounting to .001 in., an important feature for hand sizing work. These taps can be furnished in all sizes from 1⅜ in. to 12 in., inclusive.

* * *



For explanation see page 224

Among the Clubs and Associations

Southern and Southwestern Railway Club.—Frank M. Robbins, president, Ross-Meehan Foundries, Chattanooga, Tenn., will present a paper on malleable and steel castings at the May 21 meeting of the Southern and Southwestern Railway Club which will be held at 10 a.m. at the Ansley Hotel, Atlanta, Ga.

Western Railway Club. — C. N. Wright of Scottsbuff, Neb., will discuss "The Railroads—Their Condition and Needs" at the annual meeting of the Western Railway Club to be held at 8:30 p.m. on May 25 at the Sherman Hotel, Chicago. A reception at 5 p.m. and dinner at 7 p.m. will precede the meeting.

Pacific Railway Club.—"Fuel Conservation and What It Means to the Railroads" will be the topic discussed by Ralph S. Twogood of the Southern Pacific and Guy M. Bean of the American Arch Company before the May 14 meeting of the Pacific Railway Club which will be held at 7:30 p.m. at the Transportation Club, Palace Hotel, San Francisco, Calif.

A. S. M. E. Spring Meeting

The semi-annual meeting of the American Society of Mechanical Engineers will be held at Dallas, Tex., June 15 to 22, inclusive. This is during the early part of the Texas Centennial Exposition. While the headquarters for the meeting will be at the Hotel Adolphus, most of the technical sessions will be held in the Power Building and the Telephone Building, both of which are within a block of the hotel. The program now includes the following technical papers:

Wednesday, June 17
Railroad Locomotive Session
9:30 a.m.

Equipment Problems in Handling Oil as a Locomotive Fuel, by Guy Bean.
Railroad Lubricants, B. F. Hunter.
Production of Locomotive Fuel Oil, M. C. VanGundy.

3:15 p.m.
Transportation Session

Diesel Electric Locomotives for Switching and Transfer Service, R. D. Krape.
Mass Transportation for Cities, J. C. Thirwall.
Fuels for Today's and Tomorrow's Engines, Earl Bartholomew and C. D. Howley.

Machine Shop Session

The Use of the X-ray Testing of Welded Vessels, H. R. Isenburger.
The Spraying of Molten Metal, L. E. Kunkler.

Thursday, June 18
9:30 a.m.
Air Conditioning Session

Sensible and Latent Heat Control for Air Conditioning, F. W. Rabe, Jr.

Educational and Training Session

Vocational Training in the Southwest, A. W. Breeland.

2:00 p.m.
Diesel Session

Fuel Injection Spark Ignition Oil Engines, N. Fodor.
Diesel Fuels, T. B. Rendel

Annual Meetings of Mechanical Associations

The annual meetings of the following associations are scheduled to be held at the Hotel Sherman, Chicago, on September 15 to 18 as follows:

September 15 and 16

Traveling Engineers' Association
Air Brake Association
International Railway General Foremen's Association
Car Department Officers' Association

September 17 and 18

International Railway Fuel Association
International Railway Master Blacksmiths' Association
American Railway Tool Foremen's Association
Master Boiler Makers' Association

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

Air-Brake Association.—T. L. Burton, care of Westinghouse Air Brake Company, 3400 Empire State Building, New York. Annual meeting, September 15 and 16, Hotel Sherman, Chicago.

Allied Railway Supply Association.—F. W. Venton, Crane Company, Chicago.

American Railway Tool Foremen's Association.—G. G. Macina, 11402 Calumet avenue, Chicago. Annual meeting, September 17 and 18, Hotel Sherman, Chicago.

American Society of Mechanical Engineers.—C. E. Davies, 29 West Thirty-ninth street, New York. Semi-annual meeting, June 15-22, Dallas, Tex.

Railroad Division.—Marion B. Richardson, 192 East Cedar street, Livingston, N. J.

Machine Shop Practice Division.—G. F. Nordenholt, 330 West Forty-second street, New York.

Materials Handling Division. — F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.

Oil and Gas Power Division. — M. J. Reed, 2 West Forty-fifth street, New York.

Fuels Division.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

Association of American Railroads.—J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.

Division I. — Operating. — Safety Section.—J. C. Caviston, 30 Vesey street, New York.

Division V.—Mechanical.—V. R. Hawthorne, 59 East Van Buren street, Chicago. Meeting, June 25 and 26.

Committee on Research.—E. B. Hall, chairman, care of Chicago & North Western, Chicago.

Division VI.—Purchases and Stores.—W. J. Farrell, 30 Vesey street, New York.

Division VIII.—Motor Transport.—Car Service Division.—C. A. Buch, Transportation Building, Washington, D. C.

Association of Railway Electrical Engineers.—Jos. A. Andreucetti, C. & N. W., 1519 Daily News Building, 400 West Madison street, Chicago, Ill.

Canadian Railway Club.—C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

Car Department Officers' Association.—A. S. Sternberg, master car builder, Belt Railway of Chicago, 7926 South Morgan street, Chicago. Annual meeting, September 15 and 16, Hotel Sherman, Chicago.

Car Foremen's Association of Chicago.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago, Ill.

Car Foremen's Association of Omaha, Council Bluffs and South Omaha Interchange.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p. m. at Union Pacific shops, Council Bluffs.

Central Railway Club of Buffalo.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

Eastern Car Foremen's Association. — E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

Indianapolis Car Inspection Association.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

International Railway Fuel Association. — T. D. Smith, 1660 Old Colony Building, Chicago. Annual meeting, September 17 and 18, Hotel Sherman, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 West Wabasha street, Winona, Minn. Annual meeting, September 15 and 16, Hotel Sherman, Chicago.

International Railway Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich. Annual meeting, September 17 and 18, Hotel Sherman, Chicago.

Master Boiler Makers' Association. — A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting, September 17 and 18, Hotel Sherman, Chicago.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, excepting June, July, August and September, at Copley-Plaza Hotel, Boston.

New York Railroad Club.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

Northwest Car Men's Association. — E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium Building, St. Paul.

Pacific Railway Club.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately—June in Los Angeles and October in Sacramento.

Railway Club of Greenville. — J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

Railway Club of Pittsburgh.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

Railway Fire Protection Association.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md.

Railway Supply Manufacturers' Association.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

Southern and Southwestern Railway Club.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

Toronto Railway Club.—R. H. Burgess, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August.

Traveling Engineers' Association. — A. T. Pfeiffer (president), New York Central, Syracuse, N. Y. Annual meeting, September 15 and 16, Hotel Sherman, Chicago.

Western Railway Club.—C. L. Emerson, executive secretary, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

NEWS

John M. Lessells Associate Professor at M. I. T.

JOHN M. LESSELLS, until recently consulting engineer of the Westinghouse Electric & Manufacturing Company, has been appointed associate professor of mechanical engineering at the Massachusetts Institute of Technology, Cambridge, Mass. Mr. Lessells, who was born in Scotland, for 11 years was manager of the applied mechanics division of the Westinghouse Electric & Manufacturing Company at Pittsburgh and then engineering manager of the turbine and Diesel department at Philadelphia. He is editor of the Journal of Applied Mechanics published by the American Society of Mechanical Engineers.

Sante Fe Will Cut California Time and Add Two Trains on May 10

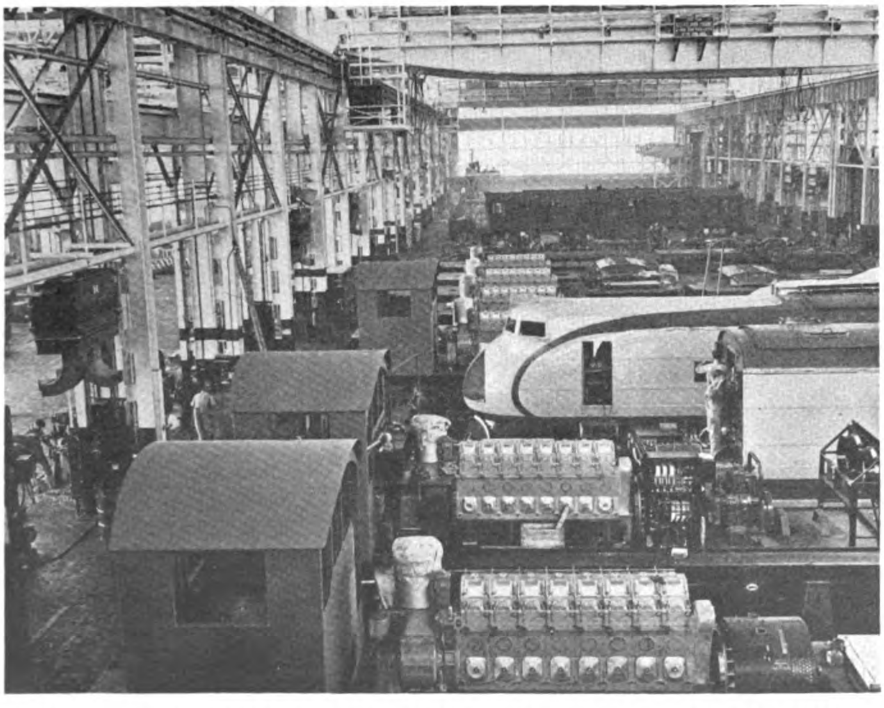
THE Atchison, Topeka & Santa Fe, on May 10, will place the Scout on a 60-hr. 55-min. schedule between Chicago and Los Angeles, Cal., and will reduce the schedule of its Chief 2¼ hr. westbound and 4 hr. 35 min. eastbound. On May 12, it will place in service the Super Chief, a train of standard Pullman equipment drawn by a 3,600-hp. locomotive, on a 39¾-hr. schedule between Chicago and Los Angeles. The Super Chief will leave Chicago at 7:15 p.m. on each Tuesday and will arrive in Los Angeles at 9 a.m. each Thursday, while eastbound it will leave Los Angeles at 8 p.m. each Friday and will arrive in Chicago at 1:45 p.m. each Sunday. The 39¾-hr. schedule of the Super Chief will be 14 hr. faster than the present fastest service between Chicago and California. Later in the year, the cars of this train will be replaced by light-weight stainless steel cars recently ordered from the Budd Manufacturing Company. The extra fare on the Super Chief will be $10.

With the inauguration of this train, the Chief, which made its first run on November 14, 1926, will operate on a schedule of 51 hr. 29 min. westbound instead of 53¾ hr. and 54 hr. 25 min. eastbound instead of 59 hr. It will leave Chicago at 12:01 p.m. instead of 11:15 a.m. and will arrive in Los Angeles at 1:30 p.m. the third day instead of 3 p.m., while returning, it will leave Los Angeles at 9:30 a.m. instead of 11:45 p.m. and will arrive in Chicago at 1:55 p.m. the third day instead of 8:45 a.m. the fourth day.

The Scout, which is designed primarily for the convenience of coach and tourist travel, will leave Chicago at 8:45 p.m. and arrive in Los Angeles at 7:40 a.m. No major changes are contemplated in the daily schedules of either the California Limited or the Grand Canyon Limited. The Super Chief, the Chief, the California Limited and the Grand Canyon Limited will all be completely air-conditioned.

Electro-Motive Diesel Plant Now in Production

THE practice period for breaking in machinery and workmen at the new plant of the Electro-Motive Corporation, LaGrange, Ill., has been completed and work is now in progress on orders for Diesel locomotives, representing an outlay of about $3,500,000. Construction of this plant, which occupies a 74-acre site on the Indiana Harbor Belt, was started in March, 1935, and completed in about seven months' time by the Austin Company, Cleveland, Ohio.



General view of the erecting shop of the Electro-Motive Corporation plant at LaGrange, Ill.

"The Making of Alloy Steel"

THE Bethlehem Steel Company has completed a new talking motion picture entitled "The Making of Alloy Steel." All of the various processes in the making of alloy steel, beginning with the charging of the open-hearth furnace through to the loading of finished bars on freight cars, are shown in this picture, also the checking and re-checking operations that are necessary in order to assure that the steel will be made according to specifications.

The explanatory lecture on the sound track follows the various processes of manufacture and explains the results obtained in the case of many of the operations and treatments.

The picture is technical throughout and takes 45 min. to show.

"City of Los Angeles" Completed

THE streamline train "City of Los Angeles" has been completed by Pullman-Standard Car Manufacturing Company and will be delivered to the Chicago & North Western-Union Pacific in a few days. After exhibitions at Chicago, Omaha, Neb., Columbus, Grand Island, Kearney, Cheyenne, Wyo., and Laramie, Ogden, Utah, and Salt Lake City and Los Angeles, Cal., Pasadena and Glendale, the 11-car train, propelled by a 2100-hp. Diesel-electric power plant, will be placed in service between Chicago and Los Angeles on a schedule of 39¾ hours for the 2298 miles, making the first trip from Los Angeles on May 15.

The streamliner will depart from these terminals each five days. "Sailing" dates from Chicago will be 6:15 p.m. on the second, seventh, twelfth, seventeenth, twenty-second, and twenty-seventh of each month and from Los Angeles at 3:45 p.m. on the fifth, tenth, fifteenth, twentieth, twenty-fifth and last day of the month. It will arrive at Chicago at 9:30 a.m. and Los Angeles at 8 a.m. the second morning. A supplementary fare of $10 between terminals will be made in Pullman cars and $5 in coaches. The nine revenue cars have a capacity for 170 passengers, 84 in the Pullmans and 86 in the coaches.

British Road Designs Car for Fragile Freight

THE Great Western of Great Britain has recently developed a new type of freight car designed to minimize damage in transport of such commodities as eggs, fruit, furniture and other fragile articles. The design of the new car is described in a recent announcement as embodying "simplicity itself," the interior being fitted with a series of partitions which can be

adjusted to hold the stacked commodities in position no matter how small the load may be.

The decision to equip 100 cars was the result of a year's experiment with 15 originally equipped. It is claimed that "this new system is the best so far devised for the protection of traffic in transit."

Report of Bureau of Explosives

W. S. Topping, chief inspector of the "Bureau for the Safe Transportation of Explosives and Other Dangerous Articles," has sent to J. M. Symes, vice-president of the Association of American Railroads, the annual report of the Bureau for the year 1935. The Bureau has now been operating for about 29 years, and the report gives a brief description of its activities. The contrast between the imperfect safety of railroad transportation, prior to 1907, with the constantly improving safety which has been reported by this bureau since then is well known.

The number of routine inspections made by the Bureau in 1935 was 23,909, a slight increase over the preceding year. In connection with rough handling of cars, the Bureau takes cognizance of other freight as well as dangerous articles, and reports that the use of impact recorders in freight cars gives increasing satisfaction. In Chicago and environs, where there is a heavy intra-city interchange of loaded cars, the use of impact recorders has been found economical.

A table is given covering 15 years, showing derailments caused by failure of arch-bar trucks, from which it is found that the major portion of the losses in this class was due to the presence of dangerous articles in the cars. This table shows, for the 15 years, 142 tank cars derailed; other cars derailed, 34; losses, tank cars, $1,631,868; other cars, $483,538.

Improvement Programs

In continuance of a program under way, the Grand Trunk Western will rebuild and modernize 600 hopper bottom coal cars and 350 box cars in its shops. Coaches used in the Detroit-Pontiac suburban service are being air-conditioned, while the air-conditioning program extends to parlor and dining cars used in Grand Trunk service. This air conditioning is in addition to the air conditioning of Pullman cars in use on the international runs between Chicago and Detroit, Mich., and Toronto, Ont., and Montreal, Que., and the sleeping cars operating to and from Muskegon, Mich., South Bend, Ind., Lansing, Mich., Flint and other services. The Grand Trunk Western also plans to purchase 100 fifty-foot automobile box cars and 100 fifty-foot gondola cars.

The Chicago, Rock Island & Pacific has given a contract to the American Car & Foundry Company to modernize seven chair cars.

The Wheeling & Lake Erie is building 50 new automobile cars and has work under way on the rehabilitation of disabled cars, in its shop at Toledo, Ohio, where three hundred fifty men are now employed.

The Denver & Rio Grande Western's $2,286,248 improvement program for 1936, authorized by the district court, covers only the first year of a comprehensive program which will require four years for completion. Among the expenditures for this year will be $250,000 for air-conditioning coaches, lounge-observation cars and dining cars which are being built at the Burnham shops.

New Equipment

Locomotive Orders

Road	No. of locos.	Type of locomotive	Builder
Joplin-Pittsburg	1	Double-unit, 70-ton propane-elec.	Fate-Root-Heath Co.
La Salle & Bureau County	1	Double-unit, 70-ton propane-elec. Plymouth	Fate-Root-Heath Co.
New York Central	7	Diesel-elec. switchers	Electro-Motive Corp.

Locomotive Inquiries

Road	No. of locos.	Type of locomotive	Builder
Alton & Southern	1	2-8-2	....

Freight-Car Orders

Road	No. of cars	Type of car	Builder
Erie	500	50-ton box	American Car & Foundry Co.
	200	50-ton automobile	Magor Car Corp.
	100	50-ton automobile (with loaders)	Greenville Steel Car Co.
Pacific Fruit Express	500	Refrigerator	General American Car Co.
	500	Refrigerator	American Car & Foundry Co.
	500	Refrigerator	Pacific Car & Foundry Co.
	500	Refrigerator	Pullman-Std. Car Mfg. Co.
	700	Refrigerator	Company shops
Seaboard Air Line	100	70-ton phosphate	Pullman-Std. Car Mfg. Co.
Wheeling & Lake Erie	50	Automobile	Company shops

Freight-Car Inquiries

Road	No. of cars	Type of car	Builder
Chesapeake & Ohio	3,500	50-ton hoppers	....
	500	50-ton flat bottom gondolas	....
	1,000	50-ton box, steel sheathed, 40 ft. 6 in. long	....
	150	50-ton drop-end gondolas, with steel floors	....
	100	50-ton drop-end gondolas, with wood floors	....
	150	50-ton automobile	....
Missouri Pacific	1,500	50-ton box	....
	500	55-ton hoppers	....
N. Y., C. & St. L.	500	50-ton box	....
	200	50-ton gondolas	....
	50	70-ton gondolas	....
	25	50-ton flat	....
	2	100-ton flat	....
Pere Marquette	400	50-ton auto-freight, 40 ft. 6 in. long	....
	100	50-ton auto-freight, 50 ft. 6 in. long	....
Western Pacific	50	Steel underframes	....

Passenger-Car Orders

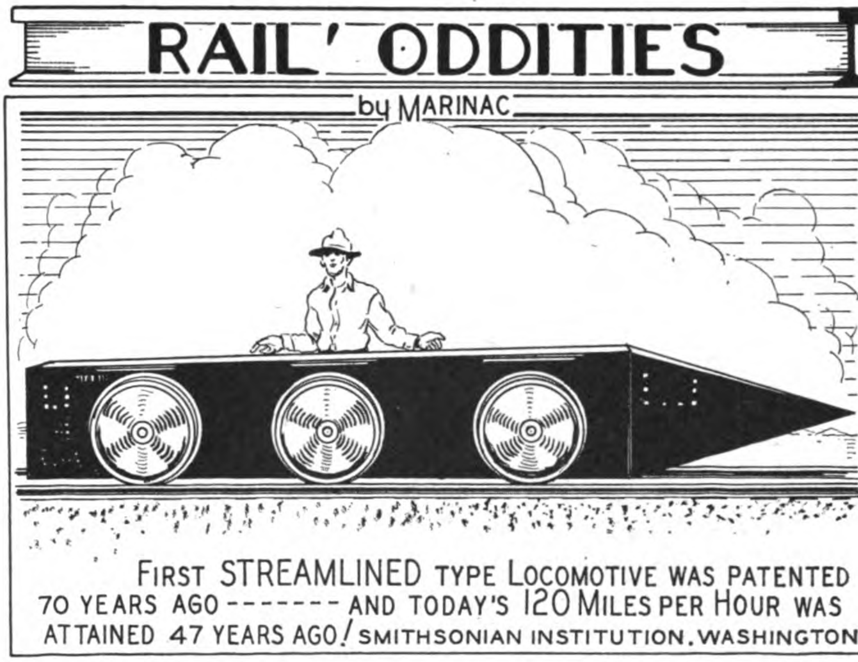
Road	No. of cars	Type of car	Builder
Atchison, Topeka & Santa Fe	1 [1]	8-car streamline train	Edward G. Budd Mfg. Co.
N. Y., N. H. & H.	50 [2]	Light-weight	Pullman-Std. Car Mfg. Co.

Passenger-Car Inquiries

Road	No. of cars	Type of car	Builder
Norfolk Southern	3	Light-weight coaches	....
	3	Light-weight pass. and bagg. cars	....
	3	Light-weight bagg. and mail cars	....

[1] This eight-car, streamline stainless steel train, for delivery within six months, will be placed in service in this company's "Super Chief" on a once-a-week round trip schedule of 39 hrs. 45 min. each way between Chicago and Los Angeles, Cal. Drawn by the company's 3600-hp. Diesel-electric locomotive, the "Super Chief" will go into service early in May on this schedule and, pending delivery of the light-weight equipment, will operate with standard steel equipment. The new streamline train will include a baggage car, a dining car, a cocktail lounge club car, four sleepers and a sleeper observation car, and will weigh about one-half as much as a conventional steel train.

[2] Twenty for main-line service and 30 for suburban service.



For explanation see page 224

Plan Drafting of National Smoke Prevention Code

PLANS are being made for the drafting of a national "smoke prevention code" with law-enforcing features at the annual convention of the National Smoke Prevention Association, which is to be held at the Hotel Ansley, Atlanta, Ga., on June 2-5. The code, which is to be drafted by representatives of various interested agencies in co-operation with the association, will be designed to be applicable to cities throughout the country. It is expected that those in attendance at the convention will include municipal officials from practically every large city, railroad officers, hotel managers and other business and industrial leaders.

Samuel W. Dudley Appointed Dean of Yale School of Engineering

SAMUEL W. DUDLEY, Strathcona Professor of Mechanical Engineering at Yale, has been appointed Dean of the Yale School of Engineering, President James Rowland Angell announced on April 21. He succeeds Dean Robert E. Doherty, who has been elected president of the Carnegie Institute of Technology.

Professor Dudley, who has been chairman of the Department of Mechanical Engineering at Yale since 1923, is one of the outstanding authorities in the application of braking mechanisms to railroad rolling stock equipment, and has played an important part in the development of the air brake. He has also done much original work with the braking equipment on electric rolling stock and high speed streamline trains.

Professor Dudley received his formal scientific training at Yale, where he graduated from the Sheffield Scientific School in 1900, and received the M.E. degree in 1903. He then joined the Westinghouse Air Brake Company at Pittsburgh, Pa., as an engineer, and soon was made local engineer in charge of the installation of electric locomotives and multiple cars on the extensive electrification projects then

S. W. Dudley

being undertaken by the New York Central and the New Haven. In 1914 he became chief engineer of the company, and remained in that capacity until 1921, when he was called to Yale to one of the newly established chairs on the foundation provided by the will of Lord Strathcona and the Mount Royal of Canada. The chair was founded in "the interest of modern science, civil and mechanical engineering."

Professor Dudley has taken an active part in transportation engineering as a member of Yale's committee on this subject and in co-operation with the Society for the Promotion of Engineering Education, the railroad division of the American Society of Mechanical Engineers, and the executives and educational directors of the railroads and the supply industry.

British to Build 587 Locomotives

BRITISH railways will build 587 new locomotives in their own shops in the near future, according to a recent announcement. Included will be 17 locomotives which the London & North Eastern will build of a design generally similar to that of its streamline "Silver Link" which now hauls the L.N.E. "Silver Jubilee" train between London & Newcastle. The decision of the L.N.E. in this connection, the announcement says, is "the result of the remarkable success which has attended the working of the existing streamline locomotives. It has been found that the streamlining has saved a great deal of power, in addition to which it has solved the problem of lifting smoke and steam so that it does not obstruct the driver's view. For high speed running at rates in excess of 60 m.p.h. it has also been found that the reduction of wind resistance effected by streamlining has had beneficial effects upon fuel consumption."

Supply Trade Notes

HARRY N. HAYES has been appointed Chicago district manager of the Coffing Hoist Company, Danville, Ill.

THE P. AND M. COMPANY has moved its office from 165 Broadway to 50 Church street, New York.

I. LAMONT HUGHES, executive vice-president and a director of the Carnegie-Illinois Steel Corporation, has resigned.

JOHN C. KEENE has been appointed sales representative of the Illinois Railway Equipment Company, with headquarters at Chicago.

THE NOLAND COMPANY, INC., Washington, D. C. has been appointed Toncan Iron sheet distributors, for the Republic Steel Corporation, Cleveland, Ohio.

SIDNEY E. TREADWELL, representative of the Railway Sales division of The Texas Company, with headquarters at Atlanta, Ga., has been appointed district manager with the same headquarters.

THE ASSOCIATION OF MANUFACTURERS OF CHILLED CAR WHEELS, Chicago, has consolidated its offices with its laboratory and research department and the combined facilities are now located at 445 North Sacramento boulevard.

THE G. M. BASFORD COMPANY, New York, has moved its branch office from 2717 Koppers building, Pittsburgh, Pa., to 422 Leader building, Cleveland, Ohio.

BRAMAN, DOW & CO., Boston, Mass., has been appointed dealer agent in the Boston area for the General Refractories Company, Philadelphia, Pa.

THE ELECTRO-MOTIVE CORPORATION, LaGrange, Ill., has moved its New York office from 10 East Fortieth street to the New York Central building, 230 Park ave.

A. F. DOBBRODT of the Chicago office of the Carboloy Company, Inc., manufacturers of Carboloy cemented carbide cutting tools and dies, has been transfered to 2802 Atkinson avenue, Milwaukee, Wis.

WILLIAM M. ROCHE, formerly vice-president of the Waugh Equipment Company, New York, has been elected vice-president of the International Supply Company, Chicago.

NORBERT E. SMITH, representative of Joseph T. Ryerson & Son, Inc., with headquarters at Indianapolis, Ind., has been appointed sales representative of the Inland Steel Company, with headquarters in Chicago.

THE WROUGHT WASHER MANUFACTURING COMPANY, Milwaukee, Wis., through its Los Angeles sales agents, the Western Washer & Manufacturing Company, is expanding its range of service in California and adjacent territory. The latter company has moved into larger quarters at 2111 East Fifty-first street, Los Angeles.

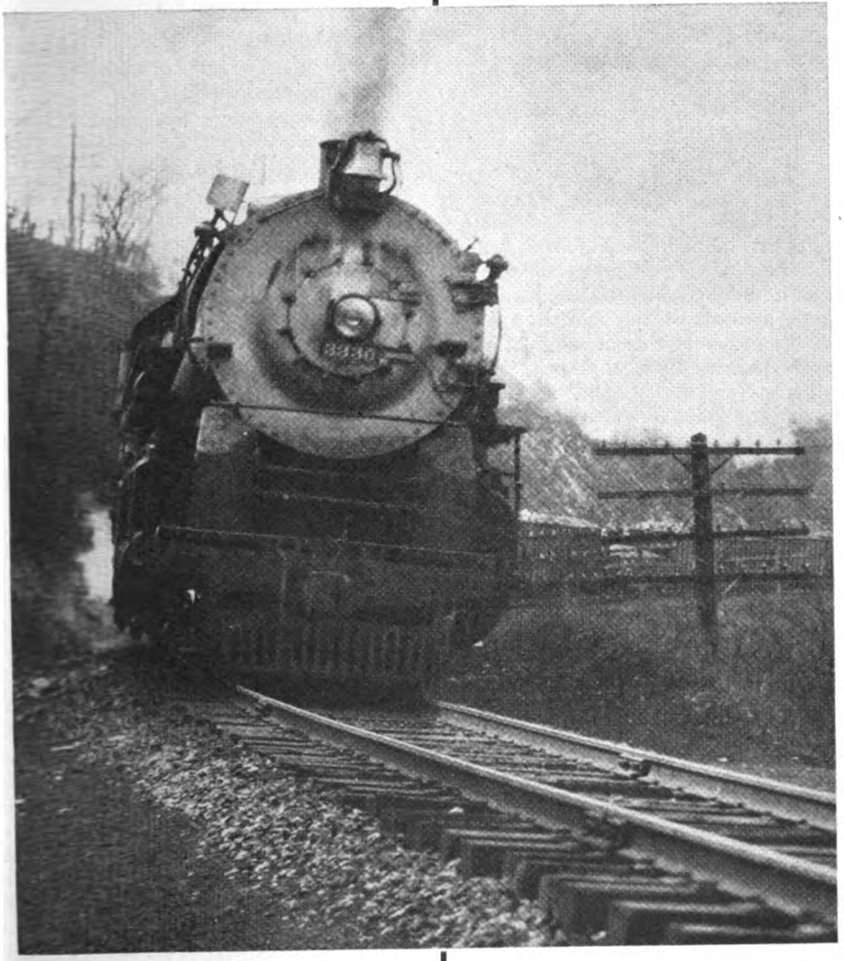
ROSS F. HAYES has been appointed eastern sales agent of the Railway Utility Company, Chicago, succeeding J. H. Denton, who has represented the company in that territory for the past 23 years. Mr. Hayes will continue his headquarters at 50 Church street, New York.

CHARLES R. SURFACE has been appointed sales manager of the P & H Electric Motor Sales division of the Harnischfeger Corporation, Milwaukee, Wis. Mr. Surface is located in the home office in Milwaukee, and is in charge of sales covering motors and electric plants.

THE REPUBLIC STEEL CORPORATION has appointed the Equitable Equipment Company, Inc., New Orleans, La., distributor of its Enduro stainless steel. The York Corrugating Company, York, Pa., and the Sheet Metal Manufacturing Company, Inc.,

(Continued on next left-hand page)

MORE TONNAGE At Higher Speeds and lower Costs



Capacity trains at higher speeds spread operating expense over more ton-miles. » Modern locomotives set the pace—they haul more tons at faster speeds — they reduce ton-mile costs. They speed up the entire railroad and increase net earnings.

LIMA LOCOMOTIVE WORKS INCORPORATED

LIMA LOCOMOTIVE WORKS, INCORPORATED, LIMA, OHIO

Stamford, Conn., have been appointed Toncan Iron sheet distributors. The latter company is a branch of the same firm in Brooklyn, N. Y., which had previously been appointed distributors of Toncan sheets.

C. RUSSELL WARREN, formerly head of the Chicago branch of L. C. Chase & Company, Inc., New York, and with this organization for the past 14 years, has been appointed sales manager for all Goodall-Sanford transportation and home-furnishings divisions at New York.

THE OWEN-DYNETO CORPORATION, Syracuse, N. Y., a subsidiary of Electric Auto-Lite, is now manufacturing and selling USL arc welding equipment. The entire engineering staff and manufacturing machinery and equipment have been moved from Niagara Falls, N. Y., to Syracuse, N. Y. J. L. Fosnight has been appointed sales manager, welder division, Owen-Dyneto Corporation.

HAROLD T. HENRY, who has resigned as eastern district sales manager of the Q & C Company, New York, to become manager of railroad sales of the Burden Iron Company, Troy, N. Y., was born at Fishkill, N. Y., in 1898, and was educated in high school and later graduated from Morrisville College, Morrisville, N. Y. He served for 16 years with the Q & C Company in various capacities, including inspection work, advertising, shop work and also assisted in the development and sales of several railroad devices both in the mechanical and maintenance departments of the railroads. Previous to that time Mr. Henry was connected with the United States Air Corps test department.

Harold T. Henry

G. M. LAUGHLIN, JR., chairman of the board of the Jones & Laughlin Steel Corporation, has announced his desire to tender his resignation as chairman of the board to take effect upon completion of current financing operations, and it is expected at that time that H. E. Lewis, chairman of the executive committee of the Jeffrey Manufacturing Company, Columbus, Ohio, and formerly executive vice-president of the Bethlehem Steel Corporation, will be elected a director and chairman of the board of the Jones & Laughlin Steel Corporation.

R. A. GRISWOLD, for many years identified with the anti-friction bearing industry, who joined the sales organization of the Bantam Ball Bearing Company, South Bend, Ind., in October, 1935, has been assigned the Connecticut and Massachusetts territory, with headquarters at Hartford, Conn.

THE FOOTE BROS. GEAR & MACHINE CORPORATION has taken over all activities and assets of Foote Bros. Gear & Machine Company, Chicago, completing the reorganization and consolidation of its activities. The officers are as follows: Franklin H. Fowler, president and general manager; W. A. Barr, vice-president in charge of manufacturing; F. A. Emmons, vice-president in charge of sales and J. R. Fagan, secretary and treasurer.

C. W. DIETRICH, JR., has been appointed sales engineer for the Torrington Company, Torrington, Conn, and the Bantam Ball Bearing Company, South Bend, Ind., to handle their bearings and specialties in the New York territory, with headquarters at 200 Fifth avenue, New York. Mr. Dietrich was graduated in mechanical engineering at Cornell University in 1918, and then served in engineering and sales capacities with the Automatic Refrigerating Company, the Hyatt Roller Bearing division of General Motors and the James T. Gordon Company.

WILLIAM O. ASHE, mechanical engineer of the Commonwealth plant of the General Steel Castings Corporation, Granite City, Ill., has been appointed sales engineer, with the same headquarters. From 1906 to 1910, he was employed in the engineering department of the American Locomotive Company at Schenectady, N. Y., and from August, 1910, to April, 1923, was with the New York Central as draftsman, chief draftsman and assistant engineer of motive power. In April, 1923, he was appointed mechanical engineer of the Commonwealth Steel Company and continued in that capacity until 1929, when the Commonwealth Steel Company became a part of the General Steel Castings Corporation. Since then Mr. Ashe has been mechanical engineer of the Commonwealth plant at Granite City.

Obituary

HARRY U. HART, vice-president and chief engineer of the Canadian Westinghouse Company, Ltd., died suddenly at Hamilton, Ontario, on March 15.

WILLIAM CHARLES PEYTON, president of the Standard Stoker Company, Inc., died on April 4 at his home in New York at the age of 67.

MAJOR CHARLES CAROTHERS, formerly representative of the Franklin Railway Supply Company, with headquarters at Chicago, died in that city on March 30 of angina pectoris.

ARTHUR G. JOHNSON, president of the Armspear Manufacturing Company, New York, died on March 21. Mr. Johnson was in his fifty-second year and had been connected with the Armspear company for 15 years.

WILLIAM A. FORBES, vice-president of the United States Steel Corporation, died on April 7 at Doctors Hospital, New York.

CLARENCE J. OLMSTEAD, who retired in 1931 as assistant to the president of the Westinghouse Air Brake Company, died at Miami, Fla., on March 23.

GEORGE G. CRAWFORD, who retired as president of the Jones & Laughlin Steel Corporation in May, 1934, and who was president of the Tennessee Coal, Iron & Railroad Company prior to 1930, died in Birmingham, Ala., on March 20.

CHARLES S. LOCKWOOD, who worked with John W. Hyatt on the invention of the Hyatt roller bearing, died in Newark, N. J., on March 20, in his eighty-sixth year. Mr. Lockwood was an active member of the Hyatt experimental laboratory staff almost up to the time of his death, his career having covered 62 years in the service. More than 44 of these years were devoted to the Hyatt Roller Bearing Company, since its incorporation in 1892. Mr. Lockwood himself took out nearly 100 patents.

CHARLES D. JENKS, president of the Chicago-Cleveland Car Roofing Company, died in San Francisco, Cal., on April 14, following a month's illness. Mr. Jenks was born in Philadelphia, Pa. He was employed in the freight and operating departments of the Pennsylvania at Philadelphia for nine years and then entered the employ of the Atlantic Refining Company, Philadelphia, in the engineering and construction department. In 1900, he became assistant to the vice-president of the Pressed Steel Car Company, with headquarters at Pittsburgh, Pa., and later was promoted to sales agent, with headquarters at Chicago. In 1910 he was appointed western sales manager of the Standard Coupler Company, with headquarters at Chicago; from 1912, to January 31, 1918, was general manager of Edwin S. Woods & Co., and from the latter date until February 28, 1923, was president and a director of the Damascus Brake Beam Company at Cleveland, Ohio. He then became vice-president of the Chicago-Cleveland Car Roofing Company at Chicago, and in 1925, was elected president.

Charles D. Jenks

(*Turn to next left-hand page*)

Personal Mention

Master Mechanics and Road Foremen

J. W. WEST has been appointed assistant road foreman of engines of the Philadelphia division of the Pennsylvania.

CHARLES W. MATHEWS, master mechanic of the Louisville & Nashville at Decatur, Ala., has been appointed to the newly created position of general master mechanic, with headquarters at Louisville, Ky. Mr. Mathews was born on July 14,

C. W. Matthews

1884, at Lyons, Mich. He entered the employ of the Louisville & Nashville on June 3, 1900, completing his apprenticeship and serving as a machinist at Decatur until May 12, 1904. From that date until June 19, 1905, he was consecutively in the employ of the Nashville, Chattanooga & St. Louis at Nashville, Tenn., the Tennessee, Central at Nashville, and the Alabama Great Southern at Birmingham, Ala., as a machinist. He then returned to the Louisville & Nashville and until May 28, 1907, was a machinist and foreman, Birmingham District. From May 28, 1907, to January 23, 1908, he was machinist and assistant night enginehouse foreman of the Alabama Great Southern at Birmingham. On the latter date he became enginehouse foreman of the Louisville & Nashville at Boyles, Ala.; on May 3, 1913, general foreman at Anniston, Ala.; on May 31, 1917, assistant master mechanic at Covington; on April 1, 1918, master mechanic at Covington, Ky., and on March 1, 1919, master mechanic at Decatur.

Car Department

H. A. GROPHE, has been appointed assistant passenger shop superintendent of the Chicago, Milwaukee, St. Paul & Pacific with headquarters at Milwaukee, Wis.

A. C. SCHROEDER, production inspector in the car department of the Chicago, Milwaukee, St. Paul & Pacific, has been appointed general foreman of the freight car shop at Milwaukee, Wis.

L. E. HILSABECK, car foreman on the Chicago Great Western at Oelwein, Iowa, has been appointed to the newly-created position of general car inspector of freight and passenger equipment, with headquarters at Oelwein.

Shop and Enginehouse

A. R. CARSON, assistant superintendent motive power shops of the Canadian National at Moncton, N. B., has been appointed superintendent of shops.

Obituary

J. E. INGLING, supervisor of fuel and locomotive operations for the Erie, with headquarters at Cleveland, Ohio, died on April 14 at Paterson Hospital, Paterson, N. J., after an illness of several weeks.

HUGH MONTGOMERY, former superintendent of motive power and rolling stock of the Rutland, with headquarters at Rutland, Vt., who died recently of heart disease, at Cocoanut Grove Fla., was born on April 26, 1864, at London, Ont., and received his education in the public schools. Mr. Montgomery entered railway service in 1879 as an apprentice on the Canada Southern (Michigan Central) and in 1884 he became locomotive fireman of the Chicago & North Western, serving consecutively as engineman, road foreman of engines and general foreman. In 1900 he was appointed road foreman of engines and later general foreman of the Central of New Jersey. In 1907 he became superintendent motive power and equipment of the Bangor & Aroostook. Mr. Montgomery was appointed superintendent motive power and rolling stock of the Rutland in July, 1913, from which position he retired in the latter part of last year.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

DIE HEADS.—The Eastern Machine Screw Corporation, New Haven, Conn., describes in a four-page bulletin H & G insert chaser die heads for use on Brown & Sharpe automatic screw machines.

UTILITY JACK.—Acco utility Jack No. 35, suitable for applications involving stretching, pulling, binding or lifting, is described in a four-page bulletin issued by the American Chain Company, Inc., Bridgeport, Conn.

PLICOTE.—Plicote, a scientifically prepared protective covering of a paint-like nature for application to metal, concrete, wood, etc., is described in a booklet issued by the Watson-Standard Company, Pittsburgh, Pa.

HICYCLE TOOLS.—Catalog No. 900, issued by the Chicago Pneumatic Tool Company, 6 East Forty-Fourth street, New York, covers a new line of Hicycle portable electric tools, including drills, screw drivers, nut runners, grinders and sanders.

PIPE THREADING AND CUTTING-OFF MACHINE.—Bulletin No. C-82 featuring the Little Landis pipe threading and cutting off machine has been issued by the Landis Machine Company, Waynesboro, Pa. This machine employs both the Landis die head and the Landis long life chaser.

MARINAC'S RAIL ODDITIES

MARINAC has furnished us with the following explanations of the three cartoons which appear elsewhere in this issue.

Page 204. Not so many years ago, before the use of electricity became common, gas lamps were used for street lighting. Promptly at twilight the gas lighter would make his rounds, many of them riding bicycles. In Kent, England, the system used by W. H. Slater, a retired naval officer, whose duty it is to light the riverside wharf lamps, recalls this old custom. Instead of using a bicycle for his five-mile trip, he has constructed a novel land yacht, and sails to his work over steel rails.

Page 212. Some of the early American railroads adopted the English practice of running trains on the left-hand side, where double tracking was used. This practice has now been changed on most roads in this country, but the Chicago & North Western still adheres to it. A heavy expenditure would be necessary to change to the right-hand side, and in addition the British practice is said to possess some distinct advantages.

Page 221. Speed—fastest thing on wheels. It made a forgotten world's record. This little streamline electric locomotive made the incredible speed of 120 miles an hour in 1889. It was designed to haul freight from New York to San Francisco in 24 hours, but an accident during a test run sent it to the Smithsonian Institution, where it has lain ever since, rusting and forgotten. The recent introduction of streamline, articulated trains caused patent attorneys to check back over the files. They discovered that the basic idea had been patented 70 years ago; it was merely ahead of its time! More recently, a general stock taking of the contents of the lumber rooms of the Smithsonian Institution, at Washington, disclosed the original of the high speed electric train.

Railway Mechanical Engineer

Founded in 1832 as the American Rail-Road Journal
With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic. Name Registered, U. S. Patent Office

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The Railway Mechanical Engineer is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.) and is indexed by the Industrial Arts Index and also by the Engineering Index Service.

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REPUBLIC STEEL

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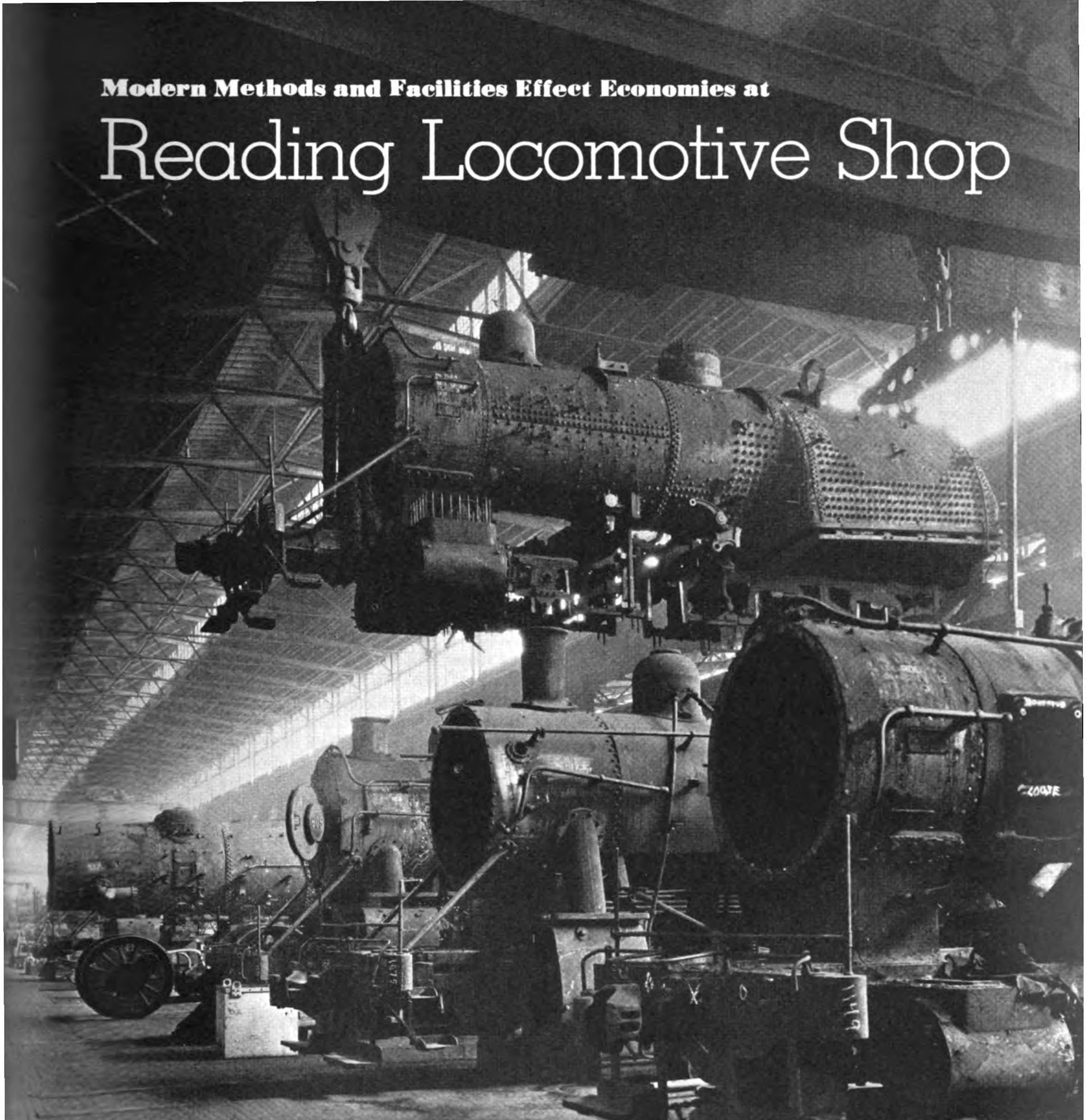
LOCOMOTIVE JACKET SHEETS

Among its many railroad specialties Republic makes steel sheets for locomotive jackets. They take a fine polish

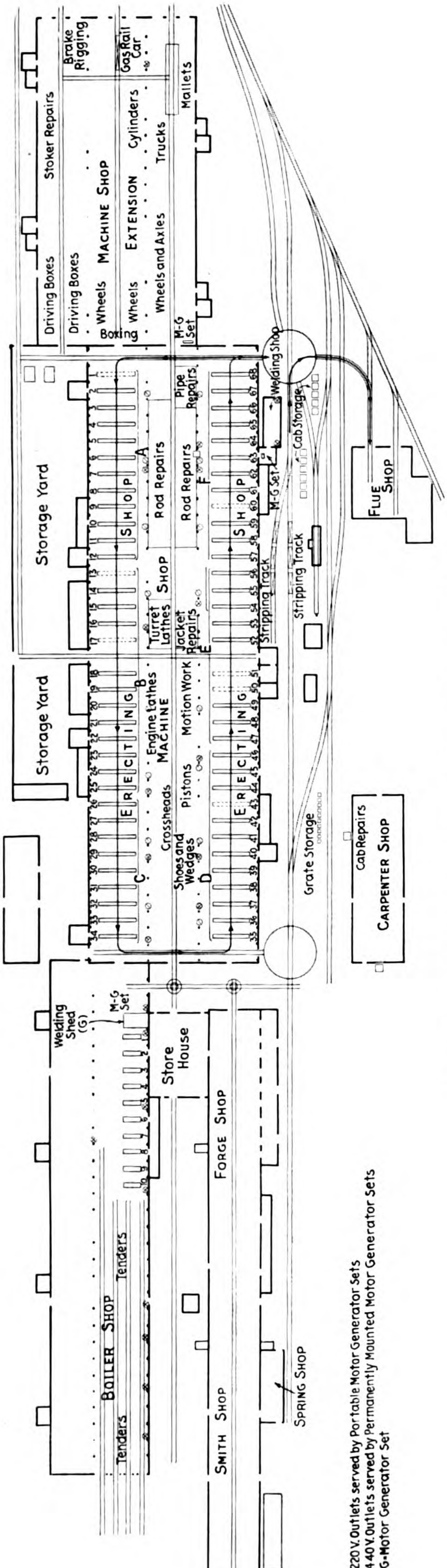
Modern Methods and Facilities Effect Economies at

Reading Locomotive Shop



Reading Lines

DURING the past six years the Reading Company has concentrated the major part of its locomotive repair work at its main shop at Reading, Pa. This shop was built in 1905 and consists principally of a main machine and erecting shop 200 ft. by 750 ft. having 68 erecting pits of the transverse arrangement, 34 on each side of the building, with a large machine bay the full length of the building between the two erecting bays. At the north end of this building and continuous with it is a 192-ft. by 404-ft. extension containing the locomotive wheel and driving box departments. In this extension are also longitudinal repair tracks where Mallet type locomotives and rail motor cars are repaired. Locomotives enter and leave the main shop by a track served by a turntable; the



Layout of the Reading locomotive repair shop showing the location of the various departments and the route taken by locomotives undergoing repair

Introduction of progressive repair system and the installation of $227,000 worth of new shop equipment contribute to a reduction of 27 per cent in locomotive shop time and 24 per cent in repair cost

machine shop extension is served by tracks entering at the north end of the building. Adjacent to the machine and erecting shop are the blacksmith shop, boiler shop, foundry and carpenter shop.

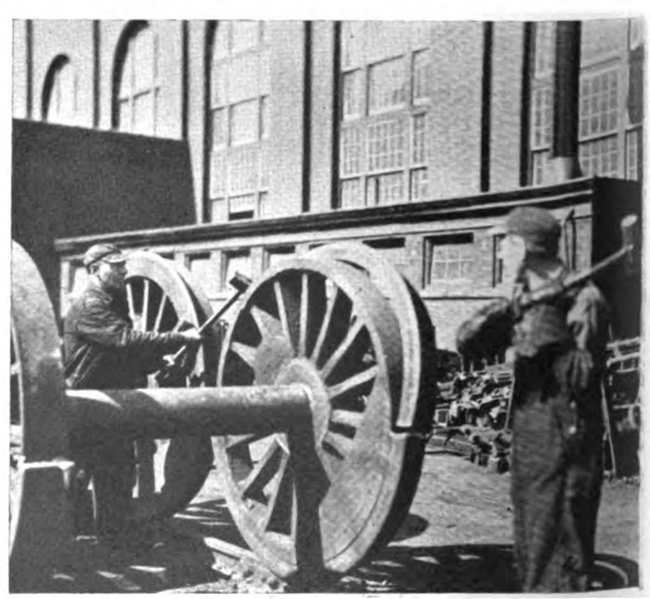
The Reading Company owns 775 steam locomotives of which 708 are of the following types:

Service	Type	No. Owned
Switching	0–6–0	72
	0–8–0	42
Passenger	4–4–0	24
	4–6–0	68
	4–4–2	22
	4–6–2	40
Freight	2–8–0	353
	2–8–2	57
	2–10–2	10
	2–8–8–2	20

Of these 708 locomotives, comprising over 91 per cent of the ownership, 306 are less than 20 years old. It will be noted that almost half of the Reading motive power, 45.5 per cent, consists of Consolidation type locomotives, 150 of which are less than 20 years old.

During the depression the Reading Company encountered problems common to most American railroads. Between 1930 and 1934 operating revenue dropped 45 per cent, with a reduction of over 30 per cent in revenue ton-miles. Transportation service locomotive miles dropped 38 per cent and, as a result, expenditures for steam locomotive repairs were reduced 47 per cent.

Faced with the problem of maintaining efficient transportation service under such conditions the management

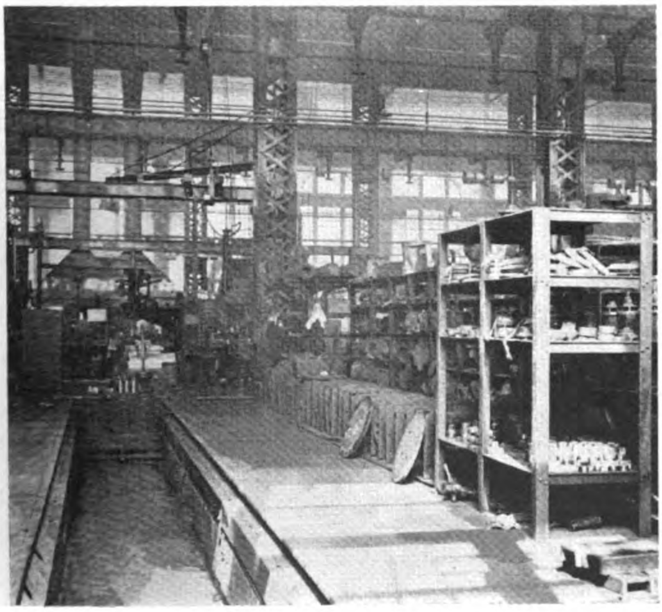


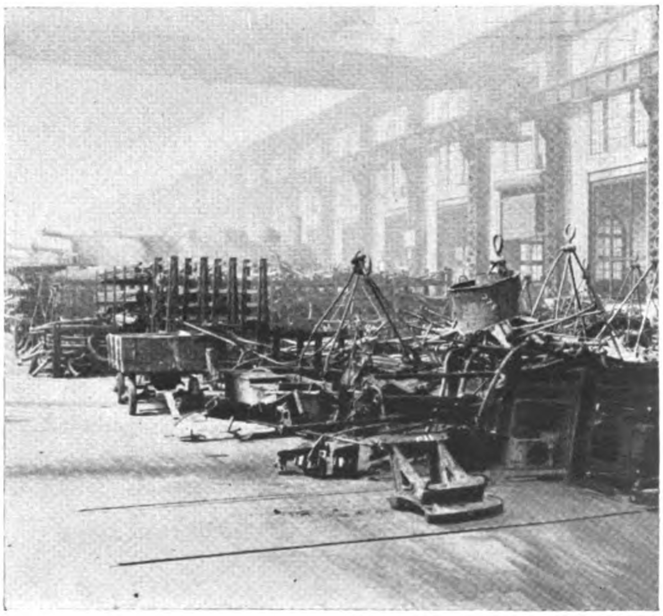
Dismantling a pair of wheels destined for the scrap pile—tires are cut through with a torch

Locomotives are stripped in Section A outside the shop

set out to adapt its operations to changing conditions. Those in charge of the locomotive repair work made detailed studies of the repair problem, particularly as related to classified locomotive repairs, with the result that in 1932 the Reading took a radical step and changed the shop operation over from the former conventional system of repairing locomotives at fixed shop locations and introduced a progressive or "spot" system of repairs, in which certain sections of the shop were equipped for specialized repair work and the locomotives moved from section to section during the progress of their passage through the shop. The results so far obtained since the introduction of this progressive system are of particular interest to railroad men because of the fact that the progressive system of locomotive repairs has not been generally believed to be well adapted to the transverse type of shop. It must be borne in mind that, under the necessarily curtailed operations of the past four years, it is not possible to determine conclusively the potentialities of any type of railroad shop repair system, but the results so far obtained at Reading, with the shop operating at not much more than 35 to 40 per cent of its capacity, indicate that the economies so far effected have justified the step that has been taken.

Once the progressive system had been established on a working basis it became evident to those responsible for shop operations that it would not be possible to effect the desired savings unless many of the older units of machine tool equipment were replaced. Consequently another series of studies were made which, when completed, pointed definitely to the fact that a modernization program as regards shop facilities would make it possible to effect substantial economies in locomotive repair work. These studies resulted in the replacement of 49 old





Two of the locations inside the shop where repaired and finished locomotive parts are stored awaiting assembly

machine tools averaging approximately 35 years in age by 32 modern machines at an expenditure of approximately a quarter of a million dollars.

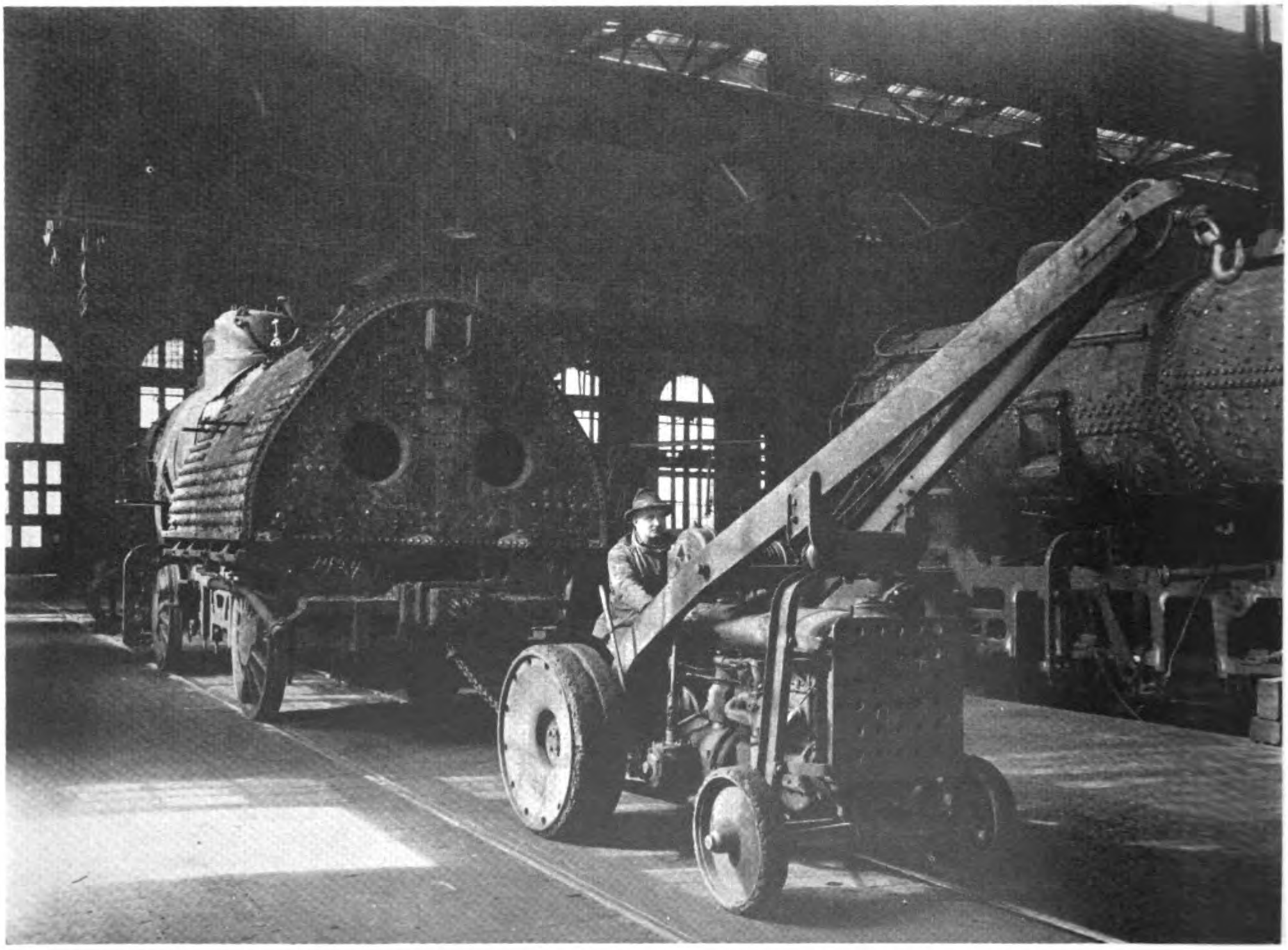
The Progressive System

The progressive system as applied to the Reading Shop is operative only in the main erecting shop, and does not apply to the work on Mallet type engines in the machine shop extension at the north end of the shop. The erecting department was originally divided into four sections, the same work being performed in each section, making it necessary for workmen to go to each of the four sections of the shop in order to perform similar work. Under the progressive system this has been changed, so that each class of work is performed in one section only. The definite operations are grouped in a sequence from beginning to end, each group being performed at designated locations which are known as "sections," there being six of these in all, three in the East bay of the shop and three in the West bay.

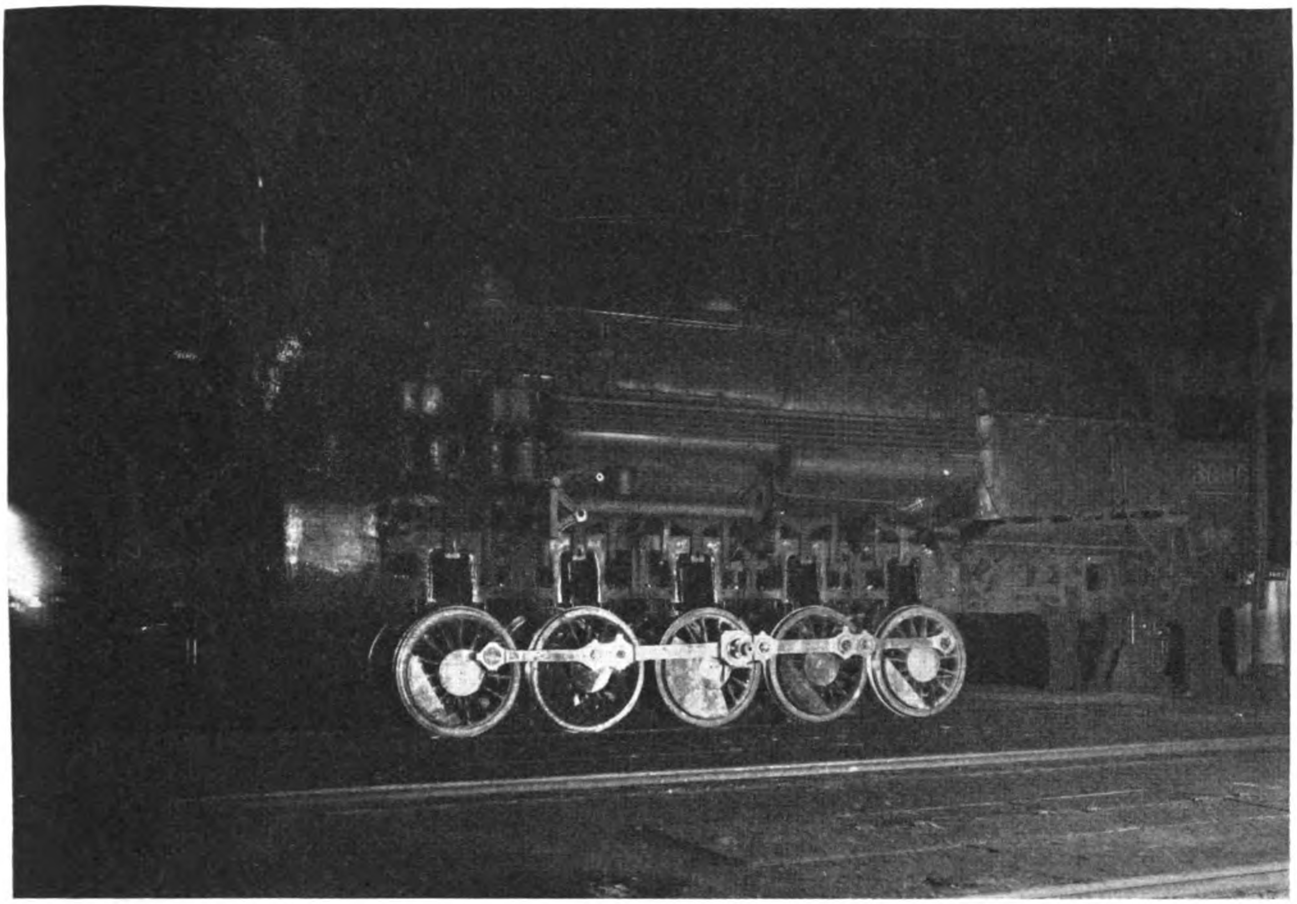
The sections are designated by letters, and each section is distinguished by a different color which appears on the section marking sign located on the shop wall. At each pit location there is also a marker sign, which shows the number of the locomotive which is on that pit at any given time. These marker signs simplify the problem of locating any particular locomotive. In general the principal difference between the progressive system and the former conventional system, is that the locomotives move to the workmen rather than the workmen to the locomotives. Individual sections of this shop have been fitted to do specialized work with convenient racks for the storage of locomotive parts. Material ordered for application to locomotives is delivered to these various sections in accordance with the schedule calling for its application. The general operations involved in locomotive repair work which are performed at each section are as follows:

Color designation	Letter	Operation
Red	A	Stripping, unwheeling, cleaning.
White	B	Light boiler work, heavy boiler work, flues applied, boring cylinders, fitting braces.
Blue	C	Light boiler work, heavy boiler work, flues applied, boring cylinders, fitting braces.
Green	D	Frame work and cylinders, dry pipe, steam pipe, throttle and throttle rigging, waist sheets, pressure fittings, testing boiler.
Brown	E	Jacket, cab, footboards, etc., grates, ashpans, smokebox, spring rigging, valve rigging, stokers, injectors, air pump, guides, pilots, couplers, etc.
Yellow	F	Wheeling, pipe work, rods applied, shoes and wedges, pedestal braces, brake rigging, valve setting, finishing, inspecting.

Inasmuch as the tracks in this shop are transverse in arrangement it is necessary to lift a locomotive by crane from one section to another. After the work in the three sections of the West bay has been completed the locomotives are moved across the South end of the shop to the East bay by means of a tractor. Each of the bays in the machine and erecting shop is adequately served by traveling cranes. Locomotives coming to the shop for repairs are moved into the shop yard and placed in the stripping location outside of the East side of the shop. This stripping location forms part of Section A. At this point, cabs, jackets, brake rigging, smokebox fronts, reservoirs, steam pipes, stokers and grates are removed. When flues require renewal they are removed at this section and an internal inspection is made of the boiler and firebox. The wheels and rods are left



After work is completed in Section C the engines are moved across the shop by tractor

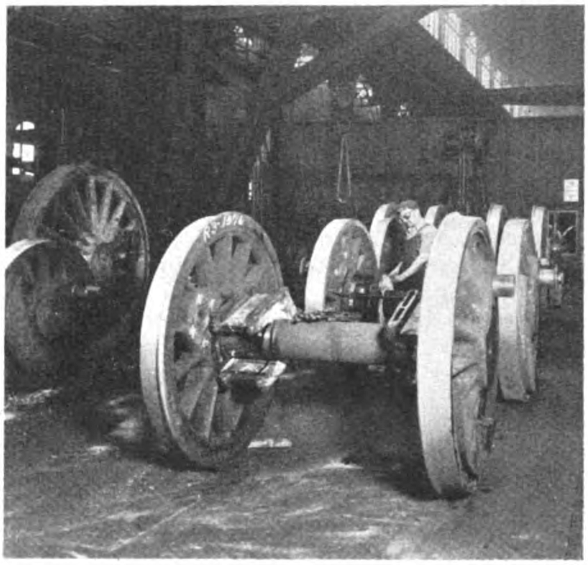


The wheeling of a locomotive is done on the night shift—the wheels, boxes and rods are made ready and the wheeling is done on a specially-equipped pit

on the locomotives to be removed later, after they have been taken into the shop. The stripping track is served by a steam locomotive crane.

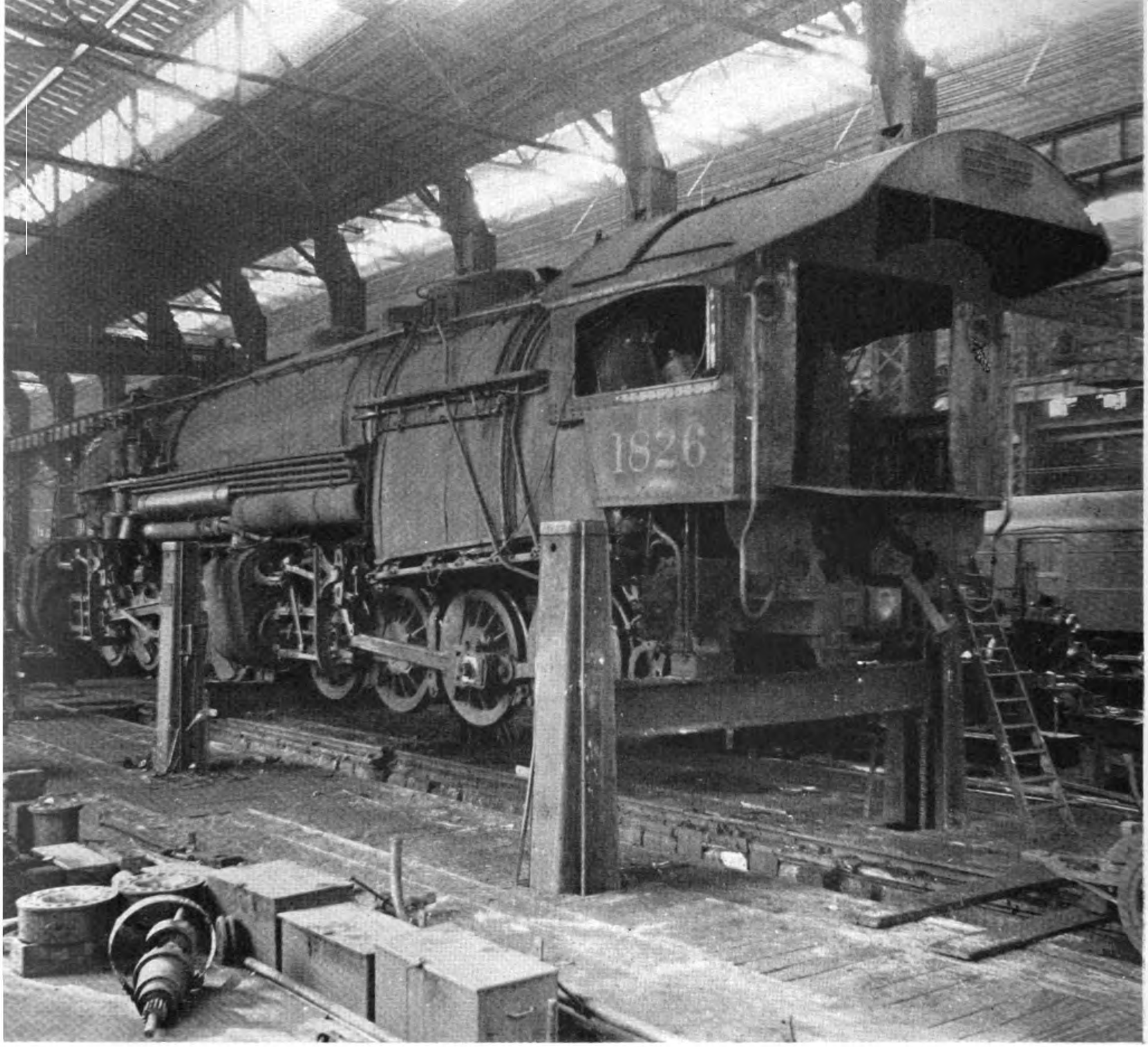
After the preliminary stripping operation has been completed, the locomotives are moved to a turntable at the northeast corner of the shop and delivered over a track extending across the north end of the erecting shop to Section A where the final unwheeling and cleaning is performed. After the parts which have been removed from the locomotives have been cleaned, (including piping, pedestal braces, clamps, steam pipes, throttle rigging, etc.), they are stored in the yard outside of the shop. Under the former system of shop operation, this material was stored in pits adjacent to the repair tracks. This caused considerable congestion in the shop and constituted somewhat of a hazard to the workmen. Under the present method this material is stored at fixed locations where it is conveniently accessible, and is delivered back to the shop at the finishing location when required.

After the work in Section A has been completed the locomotive is then lifted by the overhead crane to Section B or C. Whether a locomotive, in its progress through the shop, enters section B or C depends upon the extent of the boiler work to be performed; heavy boiler repair jobs, such as heavy firebox work, are performed in Section C exclusively. A locomotive may or may not spend time in all six sections of the shop depending upon the nature and extent of the work to be done. On particularly light repair jobs it is quite possible that certain sections of the shop may be skipped by a locomotive in its progress through the shop.



A view in the wheel department showing a workman fitting up a set of driving boxes

After the work in Section B or C has been completed the locomotive is removed by tractor across the shop to section D, where the heavy machine work such as frame work and cylinders is done. In this section such work as dry pipe, steam pipe, throttle and throttle-rigging repairs is taken care of, and the necessary tests on the boilers are made. After work in Section D is completed, the locomotive is lifted by crane to Section E which is the first of the two final assembly positions. Here the jacket, cab and running boards are applied. The smokebox work is done, grates and ashpans are applied, spring



Mallet type locomotives are repaired at a special location equipped with a Whiting hoist

rigging, valve gears, injectors, air pumps, guides, pilots, couplers, etc., are all put on.

From Section E the locomotive is lifted to the finishing section, which is designated as F. One of the pits in this section is especially equipped for wheeling engines. Here the wheels and rods are assembled, driving boxes and shoes and wedges are put up and when these parts are ready the locomotive is lifted over and wheeled. This work is done on a second trick so as not to interfere with the routine work of the first-trick workmen. After the engine is wheeled, the brake rigging is applied, the valves are set and the engine is ready for its final finishing and inspection. A certain part of the painting is done in Section F and then the locomotive is moved to the enginehouse, which lies immediately north of the shop, where the final painting is done and the engine fired up. The operations involved in Section F include the final work in the enginehouse. The finish painting of a locomotive is not done until after it has made its break-in run and all repairs and adjustments necessary as a result of the break-in have been made. This assures that when the locomotive is finally turned over to the transportation department it presents a neat appearance.

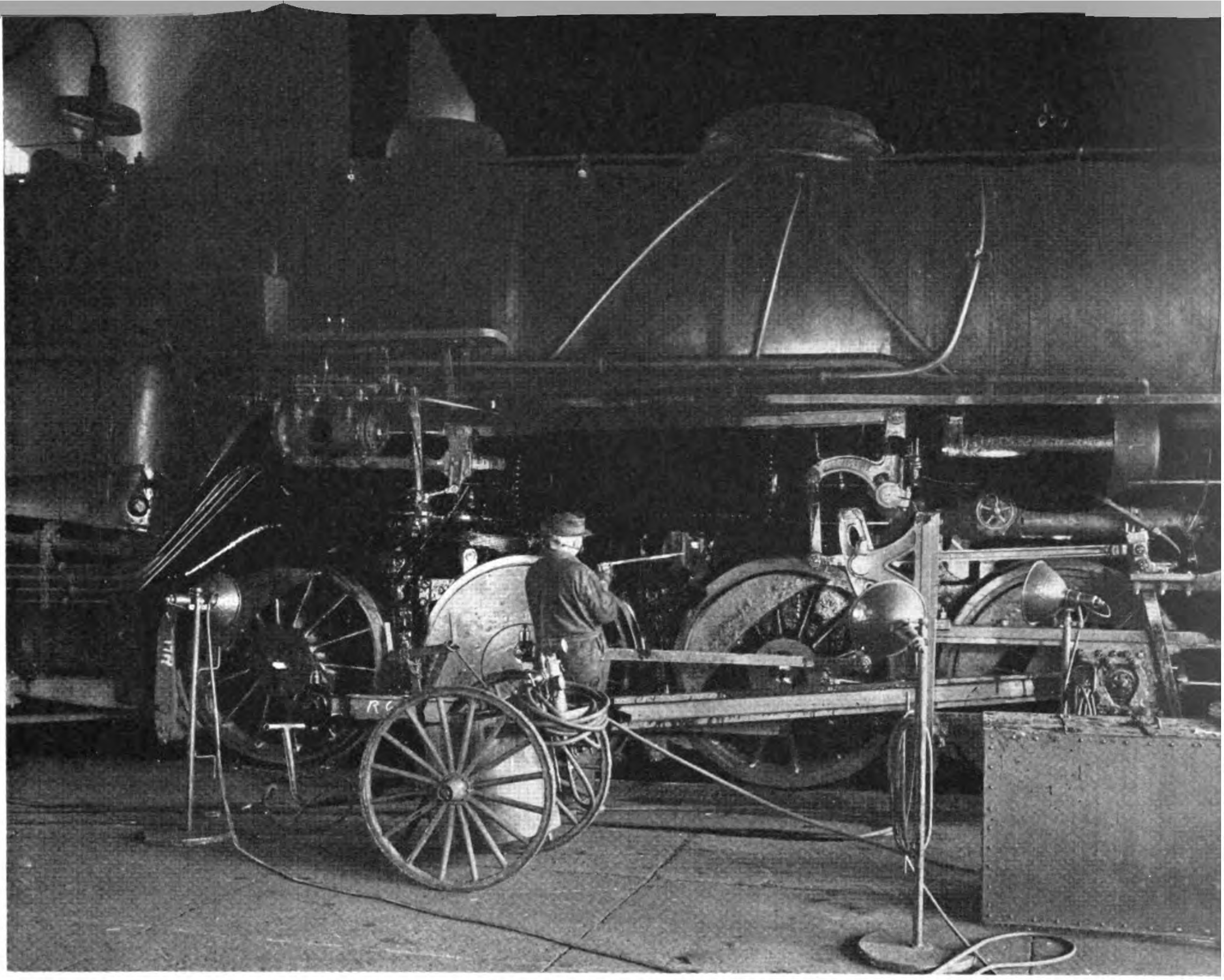
All of the operations in the locomotive department are controlled by a master schedule system. When a locomotive is taken into the shop for repairs, it is first thoroughly inspected and the class of repairs determined. Depending upon the class and nature of the repairs, a given number of working hours is allowed to complete the work on the locomotive. Each department in the shop is allowed a specific time for the completion of its part of the work and the shop supervisor follows the progress of all of the departmental work, in order that delays may be avoided. The progress reports of parts passing through repairing departments are entered on a departmental schedule form and a master schedule sheet is posted, so that it is possible to determine whether or not the work on any particular locomotive is proceeding according to the predetermined schedule.

An analysis of the number of shop days required to repair, for example, Reading type 2-8-0 or 4-6-2 locomotives shows that since the installation of the progressive system the following reductions in the scheduled time in the shop have been effected:

On Class 2 repairs	29.0 per cent
On Class 3 repairs	27.5 per cent
On Class 4 repairs	26.0 per cent
On Class 5 repairs	24.0 per cent
On recondition repairs	30.0 per cent
Average reduction	27.0 per cent

Material Distribution

At the time of the introduction of the progressive repair system a material delivery system was established, which obviates the necessity of workmen leaving their

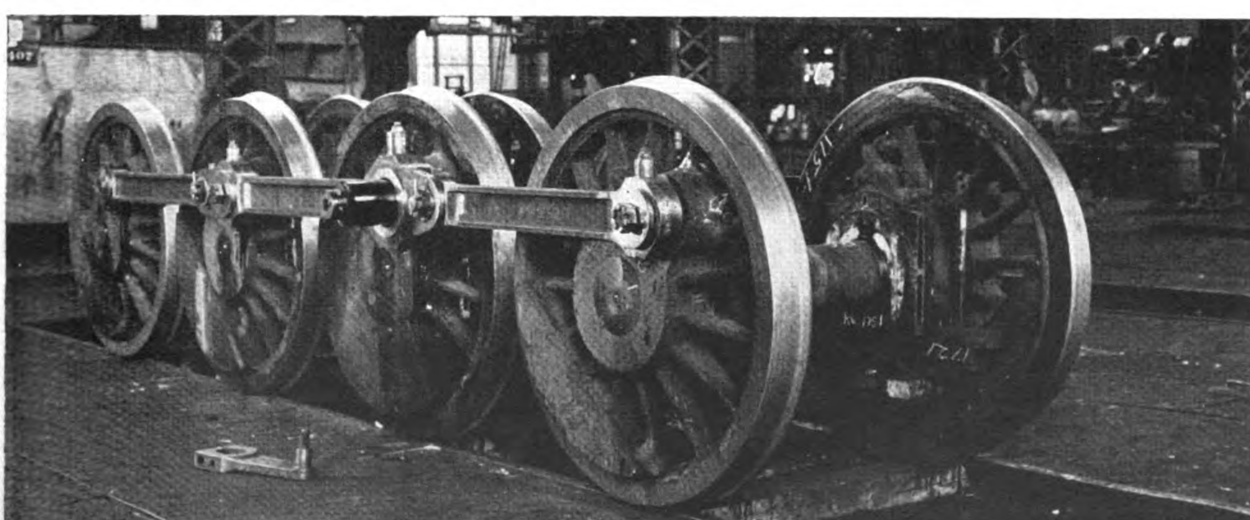


The finished painting on a locomotive is done by the spray process in Section F

posts for any material that may be required in the process of repair work. Locomotive parts which have been removed are distributed to the proper departments for repair by means of this delivery system and finished parts and material from the store house are delivered in a like manner. The delivery system utilizes tractors and trailers, and operates over eight designated routes—seven of which serve the locomotive departments. One route serves the general store house, oil house, electric and superheater repair shops; another route serves the enginehouse and wheel shop. Three routes serve the machine and erecting shops and the machine shop extension; one route serves the foundry, boiler shop and blacksmith shop, and, a seventh route operates between the main shop and the enginehouse. The eighth route is confined entirely to the car shop.

Machine Shop Modernization

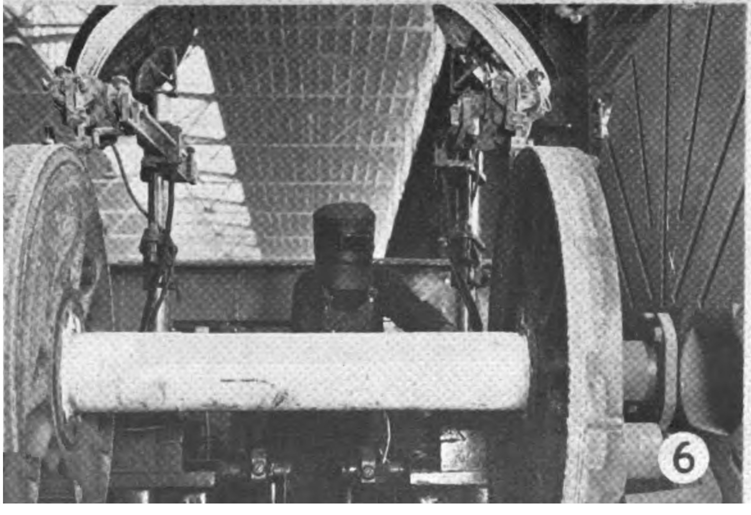
It became evident after the introduction of the progressive repair system that substantial economies could be effected by modern machine tools. There are, in the machine shop at Reading, approximately 300 major



A set of wheels, rods and boxes ready for the wheeling gang

Typical examples of the new facilities at Reading

1—One of the Warner & Swasey turret lathes
2—Metal-spraying an air pump piston
3—One of the new American radials
4—The impact wrench on staybolt caps
5—Finishing a locomotive piston head
6—Westinghouse welder for wheel centers
7—Finishing the cylinders of an air pump on the Micro grinder



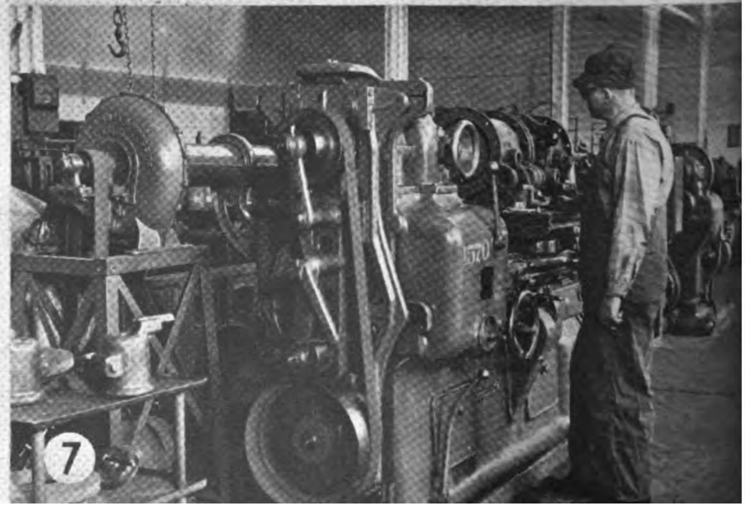


Table I—Machine Tools Retired at Reading Shops

Machine	Manufacturer	Date purchased	Age, years
28-in. engine lathe	(Unknown)	1870	66
50-in. horizontal boring mill	Wm. Sellers Co.	1882	54
52-in. vertical drill	Wm. Bement & Son	1883	53
20-in. engine lathe	E. A. Betts Machine Co.	1890	46
36-in. planer	Bement-Miles & Co.	1890	46
11-in. crank shaper	Bement & Dougherty	1890	46
30-in. vertical drill	Wm. Bement & Son	1895	41
48-in. radial drill	Wm. Bement & Son	1901	35
Four-spindle table drill	Foote-Burt Co.	1901	35
16-in. engine lathe	Lodge & Shipley	1901	35
2-in. x 24-in. turret lathe	Jones & Lamson	1901	35
36-in. x 36-in. planer	Cincinnati Planer Co.	1901	35
14-in. x 52-in. universal milling machine	Pedrick & Ayer	1901	35
36-in. vertical boring mill	Bullard Company	1901	35
31-in. metal saw	Higley Machine Co.	1901	35
16-in. engine lathe	Lodge & Shipley	1902	34
28-in. engine lathe	Schumaker & Boye	1902	34
48-in. radial drill	Wm. Bement & Son	1903	33
48-in. semi-radial drill	Bickford	1903	33
16-in. engine lathe	Harrington Sons & Co.	1903	33
24-in. engine lathe	Schumaker & Boye	1903	33
2-in. x 24-in. turret lathe	Jones & Lamson	1903	33
36-in. vertical boring mill	Bullard Co.	1903	33
36-in. vertical boring mill	Bullard Co.	1903	33
31-in. metal saw	Higley Machine Co.	1903	33
30-in. gap grinder	Norton Company	1905	31
No. 4 universal grinder	Brown & Sharpe	1905	31
24-in. drill	Baker Brothers	1905	31
36-in. vertical drill	Baker Brothers	1905	31
36-in. radial drill	Dreses Machine Tool Co.	1905	31
48-in. semi-radial drill	Bickford	1905	31
20-in. engine lathe	Putnam & Son	1905	31
16-in. engine lathe	Hendey Machine Co.	1905	31
4-in. turret lathe	Bardons & Oliver	1905	31
2-in. x 24-in. turret lathe	Jones & Lamson	1905	31
2¼-in. x 26-in. turret lathe	Bullard Co.	1905	31
3½-in. x 26-in. turret lathe	Bullard Co.	1905	31
4¾-in. x 24-in. turret lathe	Gisholt	1905	31
18-in. shaper	Cincinnati Planer Co.	1905	31
No. 5 horizontal milling machine	Cincinnati Milling Machine Co.	1905	31
67-in. vertical milling machine	Bement-Miles & Co.	1905	31
30-in. vertical boring mill	Bullard Co.	1905	31
30-in. vertical boring mill	Bullard Co.	1905	31
58-in. vertical boring mill	Colburn	1905	31
58-in. vertical boring mill	Colburn	1905	31
34-in. vertical boring mill	Colburn	1905	31
36-in. vertical boring mill	Bullard Co.	1905	31
42-in. vertical boring mill	Bullard Co.	1905	31
12-in. x 60-in. milling machine	Newton	1905	31

Average age of machines retired—34.8 years

machine-tool units. About 85 per cent of these were purchased prior to or at the time the shop was built in 1905, the remaining 15 per cent having been purchased at various times since then. There has not, however, until now, been any major tool replacement program, with the result that many of the machines had outlived their economic usefulness.

As a result of the studies made 49 obsolete machines, having an average age of approximately 35 years, were retired and replaced by modern tools. A list of the machines retired appears in Table I, and a list of the new machines installed appears in Table II.

These new tools were placed at strategic locations throughout the shop. The rod department was furnished with two new 5-ft. radial drills, an Ingersoll vertical milling machine and the two 36-in. vertical boring mills, which are used on rod bushings. The Newton crank planer was installed in the shoe-and-wedge group, while the two 42-in. Bullard vertical turret lathes were installed in the piston and cylinder group working on cylinder packing rings, piston heads and piston valve bushings. The 54-in. Bullard vertical turret lathe is equipped with a high bed for handling cylinder bushings. The remaining two 5-ft. radial drills were installed in the motion-work group of the main shop and the driving-box group in the machine-shop extension. The motion-work group also received the Cincinnati No. 5 milling machine. The three American engine lathes are installed in the piston and crosshead department.

Among the changes made in connection with the machine-tool equipment of this shop was the relocation of many machines with the idea of grouping machines so that the various groups would be self-supporting as far as machine tool facilities are concerned. In carry-

Table II—New and Rebuilt Machine Tools Recently Installed at Reading Shops

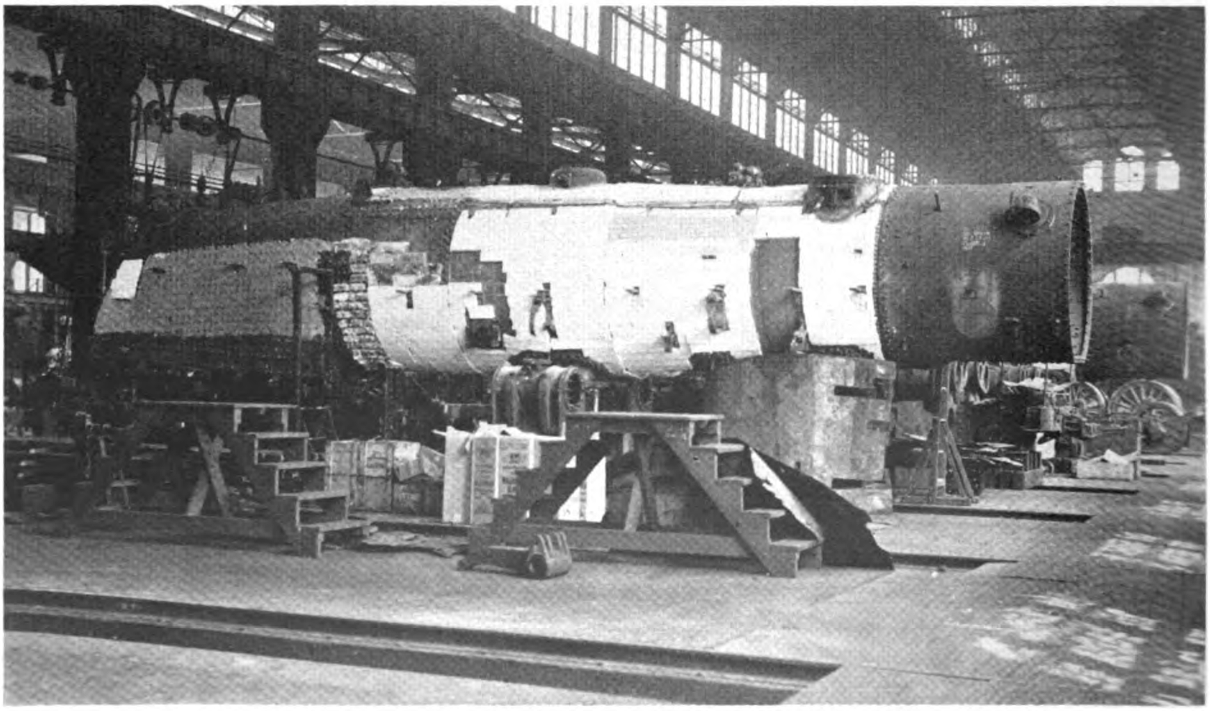
Description of equipment	Name of manufacturer	Date placed in service	Motor equipment: No. of motors	Hp.	Current characteristics	Manufacturer
Flash welder	Swift Electric Welder Co.	2/27/35	None	..	....	....
Model FG internal grinder	Micro Machine Co.	8/14/35	1	5	3 ph. a.c. 220/440	Westinghouse
			1	2	3 ph. a.c. 220/440	Fairbanks-Morse
20-in. engine lathe*	American Tool Works Co.	8/19/35	1	5	2 ph. a.c. 220/440	General Electric
Flue cut-off machine	Andrew C. Campbell Co.	8/21/35	1	7½	2 ph. a.c. 220/440	General Electric
42-in. vertical turret lathe	Bullard Co.	8/22/35	1	25	2 ph. a.c. 220/440	Allis-Chalmers
36-in. vertical turret lathe	Bullard Co.	8/22/35	1	20	2 ph. a.c. 220/440	Allis-Chalmers
54-in. vertical milling machine*	Ingersoll Milling Machine Co.	8/22/35	1	25	2 ph. a.c. 220/440	General Electric
			1	¼	2 ph. a.c. 220/440	General Electric
36-in. shaper	Ohio Machine Tool Co.	8/22/35	1	20	2 ph. a.c. 220/440	Fairbanks-Morse
39-in. crank planer	Consolidated Machine Tool Corp.	8/23/35	1	10	2 ph. a.c. 220/440	Westinghouse
			1	¾	2 ph. a.c. 220/440	Westinghouse
No. 5 milling machine	Cincinnati Milling Machine Co.	8/26/35	1	20	2 ph. a.c. 220/440	Fairbanks-Morse
32-in. × 18-in. gap grinder*	Norton Co.	9/ 4/35	1	10	2 ph. a.c. 220/440	General Electric
7½-in. turret lathe*	International Machine Tool Co.	9/13/35	1	20	2 ph. a.c. 220/440	Westinghouse
54-in. vertical turret lathe	Bullard Co.	9/16/35	1	25	2 ph. a.c. 220/440	Allis-Chalmers
Cold saw	Espen-Lucas Machine Works	9/24/35	1	10	2 ph. a.c. 220/440	Westinghouse
			1	1	2 ph. a.c. 220/440	Fairbanks-Morse
36-in. vertical boring mill	Niles Tool Works	9/25/35	1	15	2 ph. a.c. 220/440	Fairbanks-Morse
5-ft. radial drill	Dreses Machine Tool Co.	10/ 7/35	1	15	2 ph. a.c. 220/440	Allis-Chalmers
			1	½	2 ph. a.c. 220/440	Allis-Chalmers
Two No. 5 universal turret lathes	Warner & Swasey	10/14/35	1	7½	2 ph. a.c. 220/440	Fairbanks-Morse
2A turret lathe	Warner & Swasey	10/16/35	1	15	2 ph. a.c. 220/440	Allis-Chalmers
14-in. × 36-in. grinder	Norton Co.	10/24/35	1	1½	2 ph. a.c. 220/440	Allis-Chalmers
			1	1½	2 ph. a.c. 220/440	Fairbanks-Morse
			1	¼	2 ph. a.c. 220/440	Westinghouse
5-ft. radial drill	Dreses Machine Tool Co.	10/21/35	1	15	2 ph. a.c. 220/440	Fairbanks-Morse
			1	½	2 ph. a.c. 220/440	Fairbanks-Morse
Stock adjusting machine	Watson-Stillman Co.	10/25/35	1	3	2 ph. a.c. 220/440	Westinghouse
42-in. vertical turret lathe*	Bullard Co.	11/ 7/35	1	25	2 ph. a.c. 220/440	Westinghouse
5-ft. radial drill	American Tool Works Co.	11/15/35	1	20	2 ph. a.c. 220/440	Allis-Chalmers
			1	½	2 ph. a.c. 220/440	Allis-Chalmers
2¼-in. Gridley automatic	National Acme Co.	11/18/35	1	20	2 ph. a.c. 220/440	General Electric
Two 18-in. engine lathes	American Tool Works Co.	11/21/35	1	10	2 ph. a.c. 220/440	Allis-Chalmers
5-ft. radial drill	American Tool Works Co.	12/ 3/35	1	20	2 ph. a.c. 220/440	Allis-Chalmers
			1	½	2 ph. a.c. 220/440	Allis-Chalmers
Driving box oil grooving machine	Lehman Machine Co.	12/ 4/35	1	5	2 ph. a.c. 220/440	Westinghouse
14-in. engine lathe	Monarch Machine Co.	1/ 9/36	1	10	2 ph. a.c. 220/440	Fairbanks-Morse
No. 2 die sinker	Pratt & Whitney	1/23/36	1	1	2 ph. a.c. 220/440	General Electric
			1	¼	2 ph. a.c. 220/440	General Electric
Automatic wheel center welder	Westinghouse Elec. & Mfg. Co.	1/25/36	1	7½	250 volts d.c.	General Electric
Special Shop Equipment Installed at Reading						
Potts impact wrenches	Ingersoll-Rand Co.	12/26/34	..	..	....	....
Hardness tester	Wilson Mechanical Instrument Co.	5/25/35	..	..	....	....
Checking pyrometer	Thwing Instrument Co.	6/19/35	..	..	....	....
Metal spray equipment	Metallizing Co. of America	8/ 8/35	..	..	....	....
Foundry blast equipment	Pangborn Co.	8/23/35	..	..	....	....
Electric furnace for heat treating	C. I. Hayes, Inc.	9/ 3/35	..	..	....	....

* Rebuilt machine tools.

Part of the turret lathe group with new foundations ready for additional machines

ing this relocation out, the turret lathes are being placed in a turret-lathe group in the main shop. The 7½-in. Libby turret lathe and the No. 2A Warner & Swasey are located in this group, while the two No. 5 Warner & Swasey turret lathes are located temporarily in the brass-work group in the balcony over the driving-box section. The Gridley automatic is installed in the main turret-lathe group working on brake, spring-rigging and motion pins.

Another major change which has been made involving machine work has been the establishment of an air-brake shop which handles all of the air-brake work—both car and locomotive—for the entire Reading System. This air-brake department is located in the new car shop building at Reading which was built in 1927. The Model FG Micro grinder mentioned in the list of new machine tools purchased was installed in this department as was also the metal-spray equipment. The Micro grinder is operated almost exclusively on air-pump and power-reverse-gear cylinders and the metal-spray equipment is



A view in the assembly section of the erecting shop

used a large part of the time on the building-up of air-pump and power-reverse-gear piston rods.

The Influence of New Tools

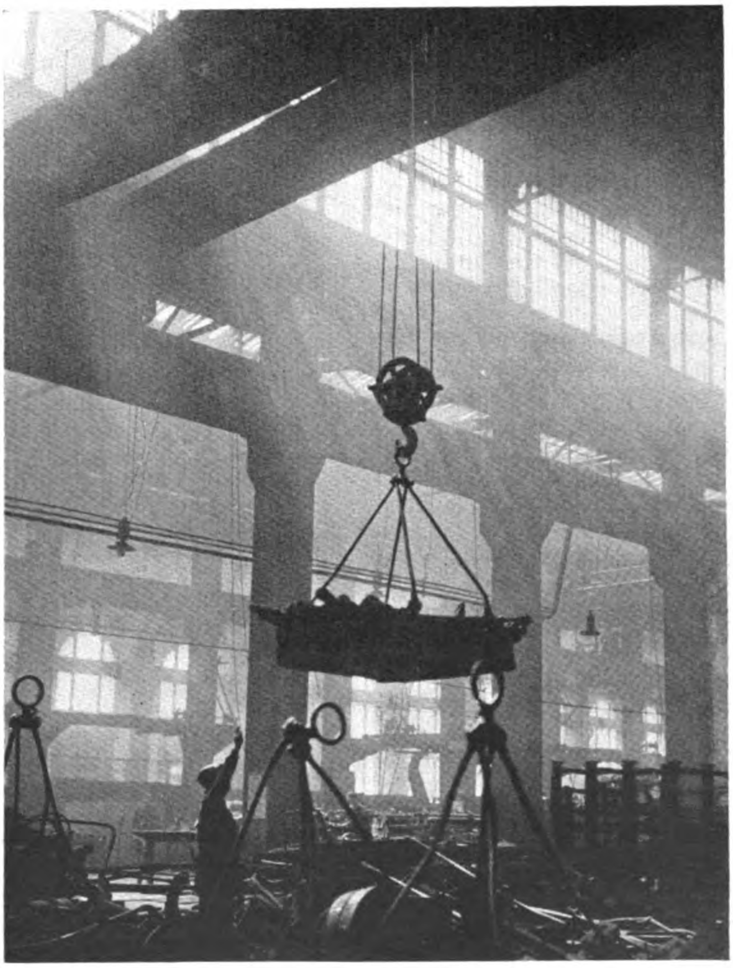
When the studies were made in 1933-1934 upon the basis of which these new tools were purchased the estimates of potential savings were predicated upon normal operations. It is worth while to point out that since that time operations have not been normal. During the year 1935 the total operating revenues of the Reading were about the same as 1933 and about four per cent greater than in 1934. Expenditures for steam locomotive repairs in 1935 exceeded 1933 by 14 per cent. The Reading Shop, on the basis of eight-hour days, worked 68 per cent of the potential number of working days—exclusive of Sundays and holidays—in 1935 but, on the basis of machine hours, the machine-tool facilities were utilized to only 35 per cent of capacity. Herein lies an important fact in relation to railroad machine tools, namely, that due to the nature of the work it is necessary to equip a shop with many tools that can not be used full time. These figures are included here to emphasize the statement that since this new machine-tool equipment was installed—mostly during 1935—conditions have made it impossible to operate it at anywhere near its full capacity. However, of the new equipment installed in the present program, involving an expenditure of $227,000, the economies effected to date show a return of 11 per cent on the investment. In view of the fact that most of the new units have been in service considerably less than 12 months and have not been used to capacity this saving indicates that many of these new tools, if operated full time, will probably pay for themselves in from three to six years. Two of the installations, particularly, have already shown economies which, on a full time basis, will pay for themselves in less than one year. A still more important fact is that the Reading, by making this installation, has profited by relatively low machine-tool prices and has placed its locomotive repair shop in a position to keep down the expenses of machining operations as the shop work builds up toward a more nearly normal volume.

Conclusion

As stated at the outset two things of major importance have been accomplished at Reading Shop since 1932—a reorganization of the method of repairing locomotives has been effected and as a result of this change in method the need for modern facilities has been indicated and acted upon. In spite of curtailed operations a saving averaging 27 per cent in the number of working days required to put a locomotive through the shop has been effected. As to actual cost the figures in Table III give some idea of what has been accomplished. They are based upon actual labor and material costs of a number of Reading type 2-8-0 locomotives given Class 3 repairs in the months indicated.

Table III—Relative Percentages of Locomotive Repair Costs

	Labor	Material	Total
March, 1930	100.0	100.0	100.0
March, 1933	81.0	65.3	73.0
March, 1935	80.5	75.8	76.0



Railroad Diesel Engineering*

By A. H. Candee†

External Regulation of Engine Output

Systems of control employing external regulating means for maintaining the generated output within the limits of engine power were developed to overcome some of the weaknesses of the differential control scheme. This external control has been accomplished in several ways, such as by a regulator which reflects engine speed (and thereby its loading), by faceplate rheostats operated in different ways, and by regulators governed by the output of the main generator. There are many such systems in successful operation today. Of these, the first system maintains the best engine loading over the widest range of train speed.

One of the disadvantages of differential control system is that the output of the main generator varies considerably with the temperature of the generating units. A low temperature exciter field winding results in high field current from the battery and therefore, high exciter voltages. This, coupled with low temperature main generator field windings, acts cumulatively to produce excess voltages for any value of motor current, with consequent overload on the engine. Actually, since the maximum fuel input to the engine is usually fixed to give full rated power and no more, the ultimate result is that the engine operates at a speed and power output lower than that for which it was applied. Another disadvantage of this control system is that both the main generator and the exciter operate with exceedingly variable voltages, so that there is no satisfactory source of power for battery charging and for operation of auxiliary equipment, unless a third machine is added and controlled to give relatively constant voltage over all ranges of engine speed and power demands of the traction motors. These disadvantages have been overcome in the externally regulated systems of control, since the excitation may be supplied from an auxiliary generator which delivers power at relatively constant voltage, and the output of the main machine is not dependent upon winding temperatures.

The foregoing has necessarily been a rather sketchy description of events which have led up to the adoption of Diesel power for railway propulsion and of the equipment involved in its use. It may readily be seen that to delve into the detail design of engines, transmission equipment, control, auxiliary apparatus, and of locomotives, rail cars and streamlined trains would extend this discussion beyond reasonable limits. It is proposed, therefore, to pass on to that phase of the engineering which deals with the application of this type of motive power to the various classes of railroad service for which it has been proven suitable and economical.

Why Railroads Use Diesel Power

The major reason for the application of Diesel motive power to railroad service is that it saves money. Of the eight expense sub-divisions—crew wages, fuel, lubrication, water, supplies, repairs, enginehouse expense, and fixed charges—six may be reduced by Diesel operation. Lubrication is increased because of the consumption of lubricating oil by the engine itself, while fixed charges are necessarily increased because of the higher first cost of this type of equipment.

Diesel switching locomotives need but one man for their operation and the railroads often find it expedient to eliminate the fireman, thus saving a large percentage of the locomotive crew cost. In addition, it has invariably been found that Diesel motive power will switch faster than steam locomotives, so that the overtime may be reduced. Where crews are paid by the hour instead of for an eight-hour trick, the crew saving may be further increased.

Rail cars have been operated for years by one man with safety. It is often stated, however, that high-speed trains (such as streamlined trains) need two men in the operating cab for safety. While this is a moot point, it is firmly believed that one operator is sufficient for this type of train on most railroads, except some of the western roads.

The reduction in the number of men in a train crew may seem to impose a hardship on this group of railway employes, reducing the number of jobs open and thus throwing men out of work. When it is considered, however, that the railroads are fighting for their very existence against highly subsidized competition, the necessity of reducing expense is of vital importance not only to the railroad, but to the employes themselves. In the end, all employes thus displaced temporarily are reabsorbed by the natural attrition which is continually going on. The only place where this reduction in force is ultimately noticeable is in the new additions to the force to fill vacancies occasioned by retirements and other natural causes.

Fuel for Diesel power is usually much less expensive than for steam locomotives. In switching work this has been found to average 25 to 33 of that of steam operation (a 75 to 66 per cent reduction in this expense item). In rail-car service somewhat similar fuel savings may be effected, although there is a considerable variation between heavy and light trains.

Water and supply expense for steam power are relative small items as compared to total expense. Repair costs, on the other hand, are of major importance, and it has been rather definitely established that those for Diesel locomotives and rail cars are well below steam maintenance expense. Enginehouse expense is also much lower than for steam because ashpits, water facilities, and expensive fueling arrangements are unnecessary, likewise the labor of tending to the motive power during layover periods is a minimum.

Aside from the economies which result from the use of Diesel motive power in switching and rail-car services, other influences sometimes demand its use for special purposes. Among these are the elimination of coal smoke from metropolitan areas and operation in arid localities where water may be difficult to obtain.

In order to determine the proper size of Diesel engine required to handle a given service—switching, transfer,

* This is the second and concluding part of a paper presented at the Massachusetts Institute of Technology, March 16, 1936, dealing with the engineering considerations involved in the application of Diesel railroad motive power to rail transportation problems.

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rail car, streamlined train or road locomotive—it is necessary to have all of the operating information and service requirements. For most services, the total miles to be operated per run, the number of stops and slow-downs, stop time, the grade and curve data of the road, speed restrictions, train weights and consists, desired schedule speed, and similar information must be obtained. Switching service, having no definite runs of this nature, is analyzed in a different manner as described later.

The Speed-Time Curve

The speed-time curve forms the basis of all application studies. From data as indicated above, a continuous speed-time curve may be prepared for the whole run, which will show the performance throughout the whole operation. In general, however, such procedure is too long and tedious for commercial applications and a close approximation is made by dividing the whole run into various representative zones and plotting a typical run for each zone.

This may better be explained by following through an actual calculation for a rail car. Assume that one zone of this rail car service is 20.9 miles long, the elevation of the various points being as follows:

Station	Mile	Elevation	Rise	Fall
Harpersville	116.0	62 ft.		
Conway	123.5	180 ft.	118	
Mile 125.6	125.6	201 ft.	21	
Jordan	128.0	154 ft.		47
Mile 128.8	128.8	140 ft.		14
Wylie Center	132.4	220 ft.	80	
East Barton	136.9	184 ft.		36
			219	97

The equivalent grade, as determined by experience, may be taken as the sum of the rises in elevation less half of the sum of the decreases, divided by the number of hundred of feet of the zone (since per cent grade is the feet rise per hundred feet). This figure, then, 219 minus 48.5 (170.5 ft.) divided by 1103.52 or an equivalent grade of .155 per cent. This method assumes that only part of the descending grades are useful in gaining momentum for swinging up the next ascending grade. Also no track curvature is given because in this zone the curves are negligible. It is customary to estimate the average curvature over the whole distance and allow .8 lb. per ton of train weight as the resistance offered by curved track to train movement.

The steam schedule as now operated on this section of the run is 30.1 m.p.h. with one minute stop time per station. The train normally handled by a steam locomotive, consists of one 60-ton (loaded) baggage and mail car and three coaches averaging 65 tons each when loaded. The Diesel train would consist of one 100-ton (loaded) motor car with baggage and mail space plus the three trailers. From experience it may be estimated that 800 engine horsepower will be required to meet the schedule. The performance of such an 800-hp. car is as follows:

Miles per Hour	Tractive Force, lb.	Amperes per Motor
4	40,000	644
6.9	30,000	514
10	22,000	407
15	15,800	320
20	12,400	268
25	9,850	230
30	8,200	200
35	6,850	180
40	6,000	*220
45	5,300	*208
50	4,750	*197
55	4,300	*186
60	3,850	*175
65	3,400	*165
70	3,000	*152

* Motor fields shunted.

Likewise, the train resistance at various speed from the Davis formula (G. E. Review, October, 1926) is tabulated:

Miles per Hour	Train resistance, pounds per ton: Leading Car	Three Trailers	Total
6.9	360	700	1,060
10	360	700	1,060
15	410	730	1,140
20	470	785	1,255
25	565	840	1,405
30	655	910	1,565
35	755	990	1,745
40	880	1,070	1,950
45	1,025	1,155	2,180
50	1,170	1,250	2,420
55	1,330	1,360	2,690
60	1,520	1,480	3,000
65	1,720	1,580	3,300
70	1,930	1,700	3,630

From these data the speed-time curve may be plotted. Fig. 6 is a typical speed-time calculation sheet and Fig. 7 is the speed-time curve. A value of 100 lb. net tractive

RR Western Run Harp'vlle - E. Barton Neg. 8432 Date 1/8/36

Weights		Equipment		Data Used	
Car	95 Tons	Eng.	1-800	Train Resistance	Davis-Tabulation
Trailing	195 Tons	Motors	4-571	Grade Resistance	.155x20x290=900
Total	290 Tons	G.R.	21-58 Wh 36	Curve Resistance	0
		Curve	Tabulation	Total Resistance	-
				Braking Rate	.75 M.P.H.P.S.

M.p.h.	Resistance: Train	Grade	Total	TF	Net TF	Accel.	dT	Sec	Motors: Amps.	Amps2 (x10⁴)
0-6.9	1060	900	1960	30000	28040	.970		7.11	514	26.4
10	1060	900	1960	22000	20040	.690	3.74	10.85	407	16.6
15	1140	900	2040	15800	13760	.472	8.60	19.45	320	10.24
20	1255	900	2155	12400	10245	.353	12.11	31.56	268	7.19
25	1405	900	2305	9850	7545	.260	16.31	47.87	230	5.3
30	1565	900	2465	8200	5735	.198	21.83	69.70	200	4.0
35	1745	900	2645	6850	4205	.145	29.2	98.9	180	3.24
40	1950	900	2850	6000	3150	.109	39.3	138.2	220	4.84
45	2180	900	3080	5300	2220	.076	54.0	192.2	208	4.33
50	2420	900	3320	4750	1430	.049	80.0	272	197	3.88
55	2690	900	3590	4300	710	.024	137.0	409	186	3.46
59.5	2985	900	3885	3885	0	0	375	784	177	3.13

Run	Miles Lgth.	Sched. Speed	Seconds: Run	Stop	Tot.	Area	Total: Run	Amps2	Sec.	H&S Amps.	Area
1	5.225	35	477	60	537	9.40	1	21	(10)6	198	4.02
2							2				
3		Adding 10% margin					3				
4		31.8			591		4				
5							5				

Sq. in. per mi. 1.8
Mi. per Sq. In. 20 x 100 + 3600 = 1/1.8
Amps2. Secs. per Sq. In. 100 x 50000 5(10)6

Calculated by A. H. C.

Fig. 6—Typical speed-time calculation sheet

force per ton of weight is assumed to produce an acceleration of one m.p.h. per second.

With the speed-time curve drawn, a planimeter is used to determine the time required for the typical run. From

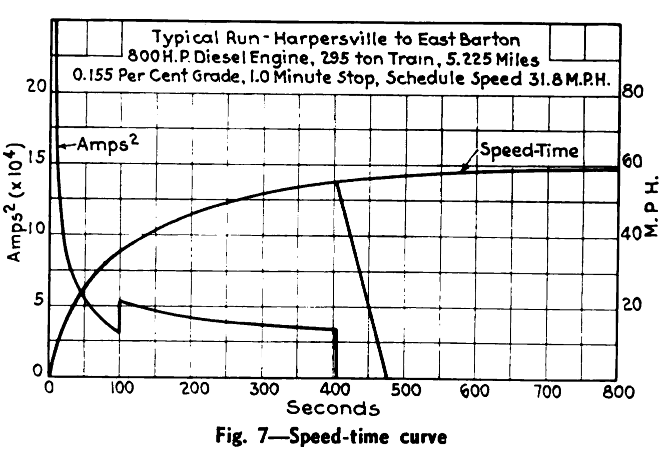


Fig. 7—Speed-time curve

the figures given, the average length of each individual run from station to station is found to be 5.225 miles, and from the calculations it is found that this requires 477 seconds running time, the train reaching a maximum

speed of 55 m.p.h. Adding the station stop time and allowing a 10 per cent margin for bad weather conditions and to permit making up time, this size of Diesel engine will haul this train over this profile at a schedule speed of 31.8 m.p.h., which is an improvement over steam operation.

To check the heating of the traction motors operating in this zone, the amperes drawn by each motor at each speed is tabulated and squared (to obtain heating value), then this squared value is plotted with the speed-time curve. Measuring the area and dividing by the total time of the run (477 running time plus 60-second stop) gives the mean squared current value, and extracting the square root gives the equivalent heating amperes for the run. This works out to be 198 amp., which is well within the continuous rating of the motor. Since the generator is applied to match the motor capacity, this is also within safe heating limits.

Analysis of Switching Performance

As has been indicated, there are no definite cycles of operating in switching service which may be calculated to determine the performance of Diesel power when applied to this work. If, however, the charac-

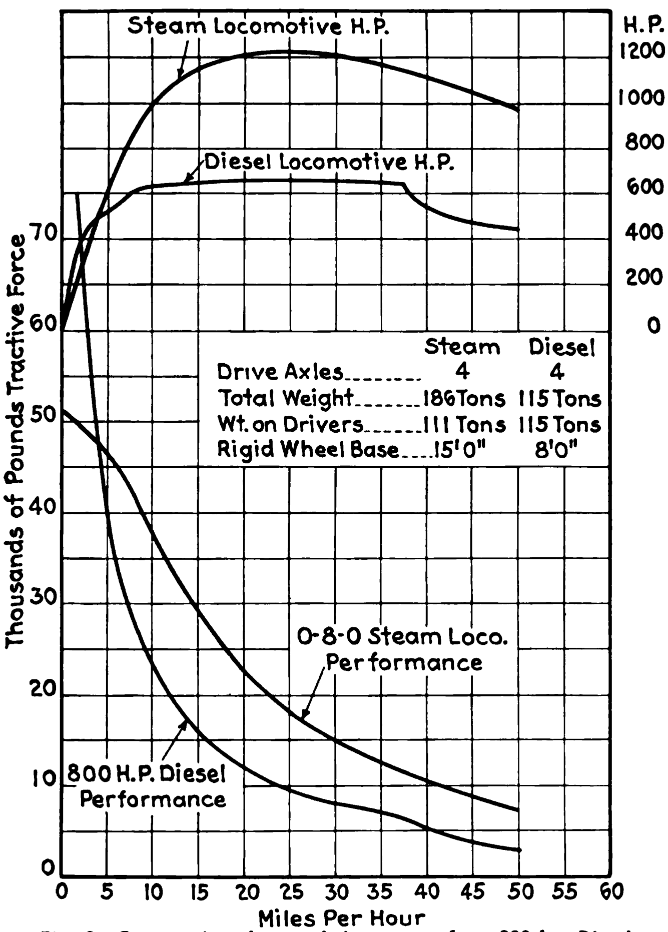


Fig. 8—Comparative characteristic curves of an 800-hp. Diesel locomotive and an 0-8-0 steam switcher

teristics of the steam power to be replaced are known, then the relative performance of the Diesel unit may be readily determined. By plotting speed-time curves of the steam locomotive pulling different weights of trains on level track and superimposing Diesel performance curves with the same weight trains, it will be noted that the Diesel has decidedly superior accelerating characteristics over the lower speed range, which offsets the improved steam performance over the higher speed range.

The curves shown in Fig. 8 are the actual performance curves of an 800-hp., 115-ton Diesel locomotive and an 0-8-0 steam switcher, the latter having the dimensions below:

Loaded engine weight	221,900 lb.
Loaded tender weight	150,700 lb.
Maximum tractive force	51,000 lb.
Factor of adhesion	4.35
Rigid wheelbase	15 ft.
Steam pressure	175 ft.
Driver diameter	51 in.
Cylinder size	22 in. x 28 in.

Consideration of these curves shows that the Diesel tractive force is superior to the steam below four miles an hour, but falls off considerably at the higher speeds. The

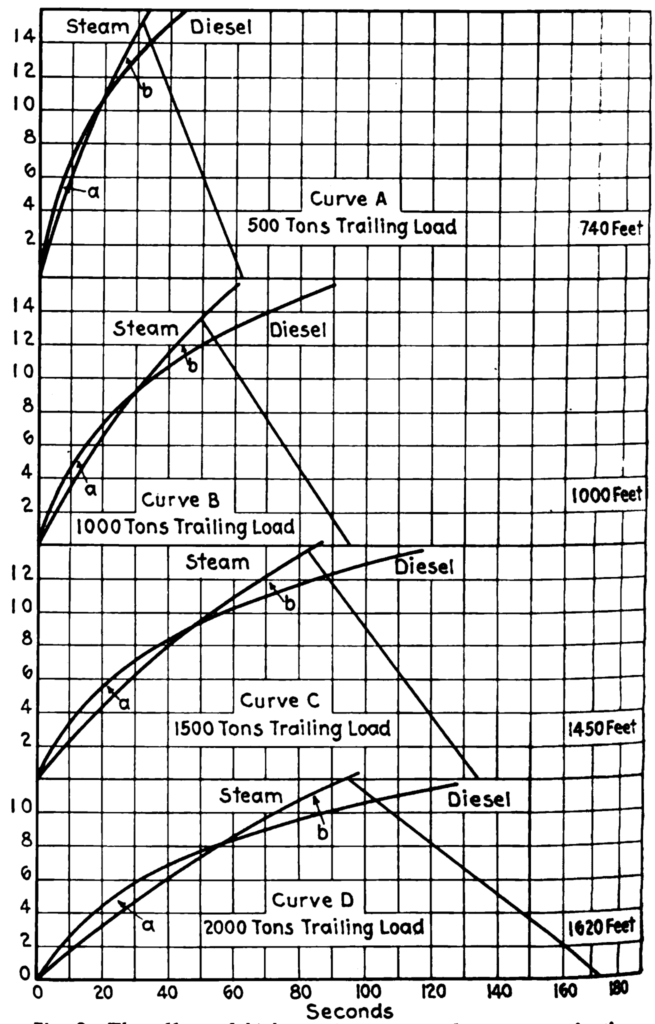


Fig. 9—The effect of high starting tractive force on acceleration

steam locomotive develops 1,220 hp., maximum, at the wheels while the corresponding Diesel output is only 657 hp.

The secret of the Diesel superiority lies in the high starting tractive force obtainable. Electric drive of the axle provides smooth and continuous application of torque, and reduces the tendency of wheels to slip, whereas the steam locomotive drive produces four distinct impulses at the wheels in each revolution. The minimum torque in a 90-deg. rotation of the wheels is 29.3 per cent less than the maximum during this same period. We have, therefore, a pulsating torque varying from 70.7 per cent to 100 per cent (with an average of 89.5 per cent) of the maximum available. Obviously, the useful tractive force of the electrically-driven wheels may be considerably higher (without exceeding the adhesive limit) than that of wheels driven by reciprocating engines through side rods. It has been

demonstrated in service that this may be 20 to 30 per cent greater than the useful steam tractive force for equivalent weight on drivers.

The effect of high starting tractive force in the acceleration of a train is shown in Fig. 9. Curves *A, B, C* and *D* are for different train weights, showing the accelerations as obtained by the Diesel locomotive with its relatively high initial tractive force, and as obtained by the steam locomotive. The Diesel locomotive has the advantage in each case, this superiority being evidenced by higher speeds up to 8 or 10 m.p.h., which is the point where the steam and Diesel acceleration curves cross. This, however, is only a part of the analysis. Area on each of these curves represents distance moved (miles per hour multiplied by time), and it may be noted from these charts that the area under the Diesel curve up to the crossing point is considerably greater than that under the steam curve. In other words, if the two equal trains started side by side, the Diesel train would be a considerable distance ahead of the steam train when they reached the same speed. If then, the steam train is to catch up to the Diesel train, it must move faster than the Diesel to regain the area (distance) lost up to 8 or 10 m.p.h. The two locomotives continue until the area *b* is equal to the area *a*. If both are then braked to a stop at the same rate, they will come to rest at the same point. Measuring the areas, it is found that the length of runs for which these locomotives give equal performance are: 500-ton trailing load, 740 ft.; 1,000-ton trailing load, 1,000 ft.; 1,500-ton trailing load, 1,450 ft.; 2,000-ton trailing load, 1,620 ft.; and that on all runs shorter than these the Diesel is actually faster.

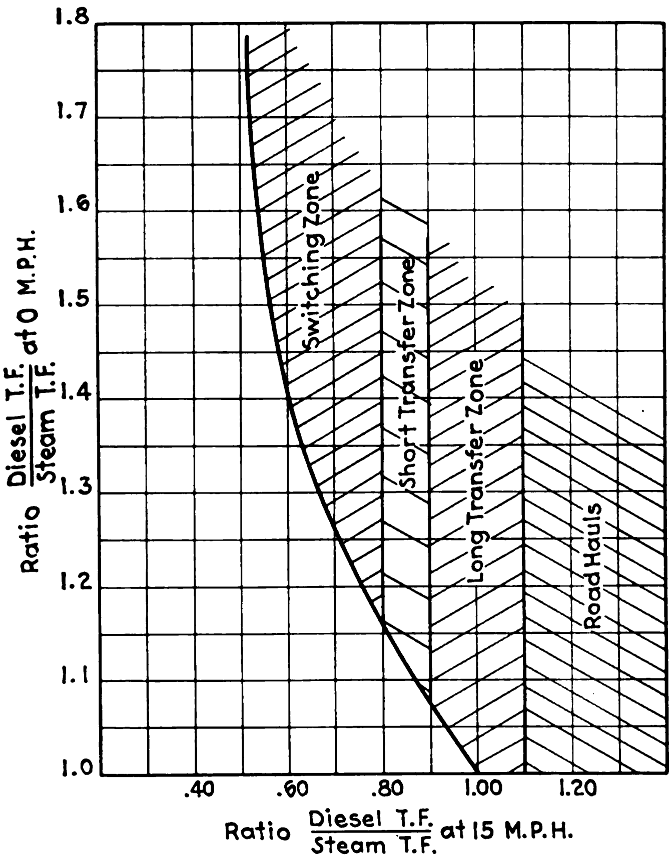


Fig. 10—Approximate guide for the selection of Diesel switcher size

The average length of run in yard service as recorded for 21,750 movements on 12 different railroads is 582 ft., and the average trailing load is 306 tons. The curves indicate, therefore, that the 800-hp. Diesel locomotive can perform faster than the 0-8-0 steam locomotive in practically any normal yard operation.

Comparisons such as just shown have been made for a great many locomotives. In order to derive a quick method of selecting a Diesel locomotive to replace a known steam locomotive in switching service, a curve as shown by Fig. 10 has been drawn. By plotting the ratio of starting tractive forces of the two units and the ratio of tractive forces at 15 m.p.h., account has been taken of the Diesel starting advantage and of the higher steam power at higher speeds.

One factor which enters into the application of Diesel switching motive power is that of the short time rating of the electrical equipment. Conditions are often encountered where the locomotive has a heavy train and a stiff grade to negotiate in making a transfer movement. To provide ready means of checking the approximate limitations of the motors and the generator from a safe heating standpoint, a curve has been prepared for each locomotive size, one of which is shown by Fig. 11. For instance, if in a transfer movement the grade starting out of the yard is 0.6 per cent for three miles, the permissible train which may be handled is determined by starting at the three-mile point and going vertically to the T. F.—Distance curve. Then by horizontal translation to the grade line and from there down to the base line again it will be found that 2,450 tons may be safely handled. This, of course, assumes that the motors start this run at a temperature not exceeding 75 deg. C above ambient temperature. Actually, switching service is so varied and requires so little work from the traction motors that the motors usually start a run of this nature at a much lower temperature.

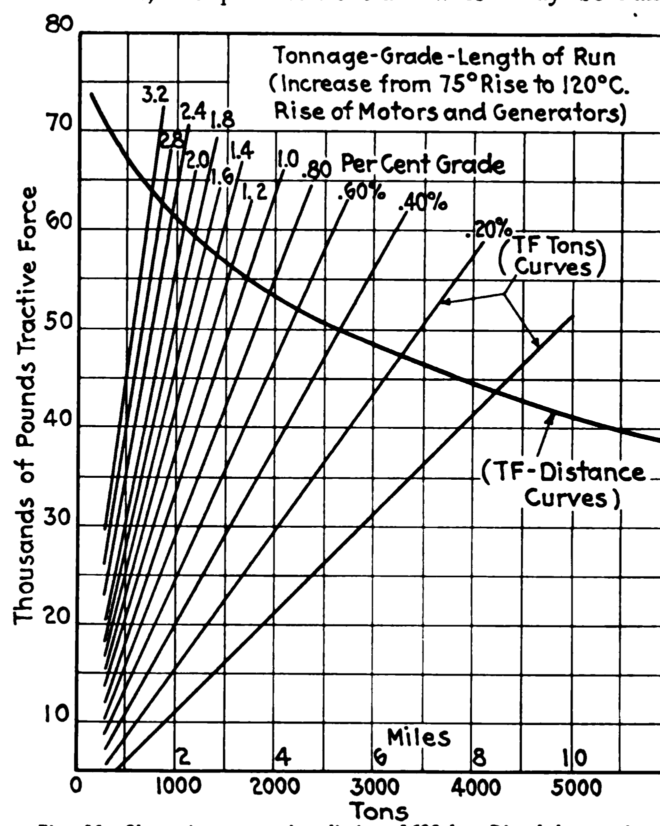


Fig. 11—Short-time operating limits—1600-hp. Diesel locomotive

The calculation of a curve such as Fig. 11 requires a knowledge of the time-temperature characteristics of the electrical machinery. Unfortunately, in the production of commercial motors and generators, elaborate tests may not always be made because both time and

expense must be conserved while calculations alone will not give the data required. However, from a few tests made on different motors, Fig. 12 was prepared to show the approximate time rating of railway motors such as are used on Diesel locomotives. Since the fundamental basis for the calculation of Fig. 11 is approximate, it may readily be seen that this should be used with care.

Streamlined Train Application

The predetermination of engine size and train performance of a unit train involves a number of new factors upon which there is little verified data. This is based upon such trains being constructed with aerodynamically designed exteriors, of extremely light weight,

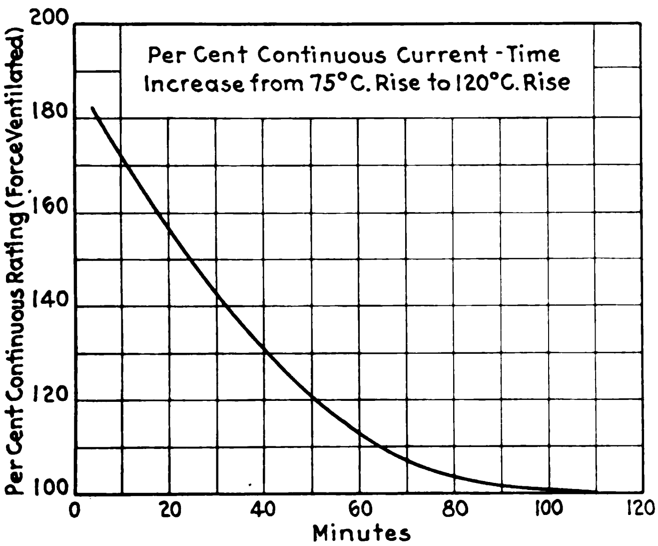


Fig. 12—Estimated railway motor time—temperature curve

articulated car bodies, and for high-speed operation. The most vital consideration is the air resistance to be used in calculating the performance.

There have been many tests carried out for the purpose of deriving constants by means of which streamlined train resistance may be calculated. A series of articles published in the *Railway Mechanical Engineer* issues of August, September, and October, 1934, covers a great many tests which have been made, but still leaves us without a practical formula for commercial application work. Most engineers, however, are familiar with the Davis formula, and so this is generally used as the basis for streamlined train resistance estimates, modifying the constants to allow for the aerodynamic improvement.

The Davis formula is:

$$\text{Resistance} = 1.3 + \underbrace{\frac{29}{W}}_{\text{Journal Friction}} + \underbrace{0.045V}_{\text{Flange Resis.}} + \underbrace{\frac{K}{WN}AV^2}_{\text{Air Resis.}}$$

W = Tons per axle
V = Speed in miles per hour
N = Number of axles
A = Frontal area of train in square feet
K = Windage constant:
0.0024 for conventional type head car
0.00034 for conventional type trailers.

Experience has indicated that for streamlined trains the values of K may be reduced to the following values, which are from 40 to 60 per cent of standard values.

For head-end car	.00096 to .00144
For trailers	.000136 to .000204

Since the application engineer must make no mistake in applying a train of this nature, costing hundreds of thousands of dollars, it is almost imperative that the higher values of K be used.

Fig. 13 is shown to indicate the relative train-resistance values between conventional types of cars and streamlined trains. This is for a train such as the New Haven "Comet."

With the train resistance determined, the rest of the calculations are similar to those of a conventional train. However, since the power required for auxiliary purposes is high (air conditioning and lighting loads are large), care must be taken to determine the real power available from the engine for propulsion purposes.

In an effort to reduce the amount of work necessary in applying Diesel equipment to high-speed trains, it has often been found expedient to plot a typical curve of the accelerating characteristics from start to balancing speed, or the permissible speed limit if this is lower than the balancing speed. By drawing in the braking lines from the maximum speed to lower speeds and using a planimeter to measure the areas, the distance (and hence the time) lost each time the train speed is reduced and re-accelerated may be determined. Then, by taking the full-speed time between terminals and adding the time required for each slowdown, for each mile of slow-speed operation, and the station time for each stop, the total running time may be approximated.

The curve shown by Fig. 14 indicates the method of plotting the acceleration and braking curve. The full-speed mileage, slowdowns, and slow running zones of the run for which this curve was prepared are tabulated:

Miles	M.p.h.
343.55	90
32.75	80
1.75	75
8.00	70
7.50	60
2.65	40
1.50	30
1.15	25
1.00	20
.15	15

No. of slowdowns from 90 m.p.h.	
6	80
8	75
5	70
2	60
6	50
1	45
5	40
1	30
3	25
1	20
1	15
7	0

6 intermediate stops of 2 min. each

From Fig. 14 the time lost per slowdown has been determined. Likewise, the time lost per mile of slow running at different speeds has been figured. This is:

Slowdown to, and restoration from m.p.h.	Time lost, min. (per slowdown)
80	.27
75	.47
70	.68
60	1.13
50	1.47
45	1.70
40	1.87
30	2.15
25	2.35
20	2.50
15	2.65
0	3.00

Running at m.p.h.	(Per mile)
80	.09
75	.14
70	.20
60	.34
40	.84
30	1.34
25	1.74
20	2.34
15	3.34

By this method it may be determined that the total time of the run is 361.58 minutes, or a scheduled speed of 66.3 m.p.h. This is figured by adding the lost time to that required if the whole run were at 90 m.p.h., as follows:

Miles	Speed, m.p.h.	Running time, min.
400.00	90	267.00
32.75	80	*2.95
1.75	75	.25
8.00	70	1.60
7.50	60	2.55
2.65	40	2.23
1.50	30	2.01
1.15	25	2.00
1.00	20	2.34
.15	15	.38
Stop time		12.00
Time		295.31

Slowdowns No.	to m.p.h.	
6	80	1.62
8	75	3.76
5	70	3.40
2	60	2.26
6	50	8.83
1	45	1.70
5	40	9.35
1	30	2.15
3	25	7.05
1	20	2.50
1	15	2.65
7	0	21.00
Total time of run		361.58

* These and the figures following are the time in excess of that required to make the same distance at 90 m.p.h.

Diesel Locomotives for Road Hauls

One reason for the improvement of switching service by Diesel motive power is the fact that the time out of service for fueling, inspection, and repairs is much less than for steam, thus giving a higher availability factor. Where Diesel locomotives are used for hauling freight or passenger trains, the scheduling of trains limits the amount of time of Diesel use per day. It has also been determined that as the sustained load on the locomotive increases, the relative difference between steam fuel and Diesel fuel decreases. In other words, the advantages of Diesel power decrease with the heavier trains and longer hauls, whereas the purchase price differential increases and the higher fixed charges eat heavily into the savings effected. For this reason the main line Diesel locomotive may not yet be considered competitive with steam, although there are a number of tests being carried on at present to determine the exact field for such units.

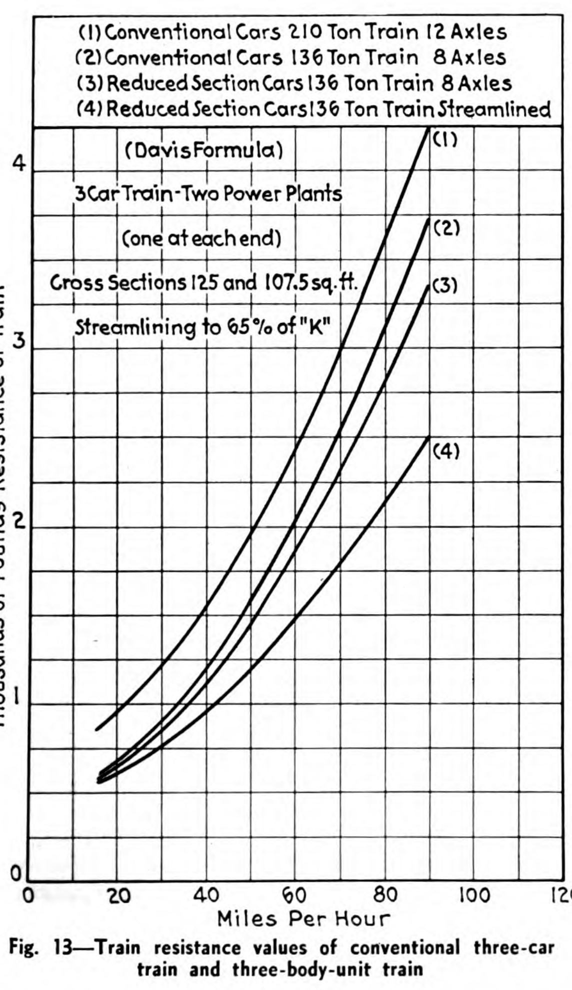


Fig. 13—Train resistance values of conventional three-car train and three-body-unit train

Savings by Diesel Motive Power

With the size of engine and equipment determined for a given service and its performance known, the engineer may next prognosticate the operating costs. To do this, however, requires a background of accumulated

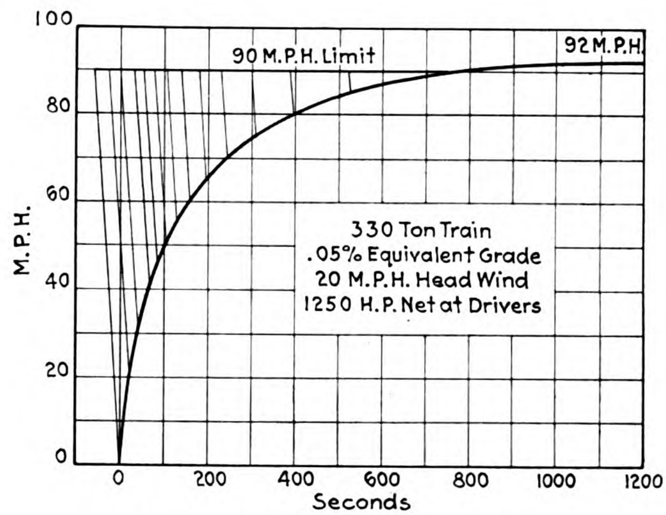


Fig. 14—High-speed train accelerating curve

service and cost information. Because of the voluminous character of these data they may not be included here, but typical cost comparisons as derived from such data are presented.

The first tabulation is that of an actual study where it is proposed to use baggage-mail rail cars, each equipped with a 1,060-hp. engine, hauling from four to six trailing cars. Two such cars will handle four runs, making a total of 168,000 miles per year (84,000 miles per car).

Typical Rail-Car Cost Comparison

Expense item	Dollars per month Steam	Dollars per month Diesel
Wages, engineman	$1,008.16	$1,008.16
Wages, fireman	746.62	....
Wages, conductor	728.24	728.24
Wages, baggageman	510.80	510.80
Wages, flagman	506.69	*........
Fuel	1,730.74	786.50
Power equipment repairs	2,833.42	1,305.72
Water	216.00	....
Lubrication	110.26	188.64
Enginehouse expense and miscellaneous	66.74	42.07
Train supplies	416.59	416.59
Car repairs	1,244.14	1,419.81
	$10,118.40	$6,406.53
Operating expense per year	$121,421.00	$76,878.00
Savings per year by Diesels	....	44,543.00
Savings, approximate per cent on net investment	....	20

* It has been customary to reduce train crew on motor-car trains by eliminating the flagmen.

This comparison does not include fixed charge because it was desired to determine the time in which the investment could be completely written off of the books by applying all of the savings for this purpose. As may be noted, this will take slightly over five years.

The operating savings by the use of Diesel switching locomotives are shown by the tabulation which follows. In this comparison are shown the present cost of operating old steam power, the reduction in cost effected by the purchase of new (improved) steam locomotives, and by the use of Diesel locomotives. There has been a concerted drive by some of the steam-locomotive manufacturers to try to stem the rising tide of Diesel substitutions by proposing such new and improved steam power, but the total savings by Diesels so far outweigh those of new steam that such a campaign has had little effect.

TYPICAL SWITCHING COST COMPARISON

	Old steam	New steam	Diesel
Regular hours	28,848	28,848	26,553
Overtime hours	1,389	1,389	347
Wages, straight time:			
Enginemen	$26,194.27	$26,194.27	$24,163.23
Firemen	20,530.29	20,530.29	....
Foreman	25,436.43	25,436.43	23,368.84
Switchmen	51,582.38	51,582.38	47,529.87
Total	$123,743.37	$123,743.37	$95,061.91
Wages, overtime:			
Enginemen	$1,980.62	$1,980.62	$494.47
Firemen	1,541.52	1,541.52	....
Foreman	1,918.69	1,918.69	478.86
Switchmen	4,074.10	4,074.10	1,016.71
Total	$9,514.93	$9,514.93	$1,990.04
Fireman allowance for cleaning fires	$913.36	$913.36	....
Total crew wages	134,171.66	134,171.66	$97,051.95
Coal—10,803 tons	42,347.76	31,760.82	....
Oil—163,000 gals.	....	....	8,150.00
Water	1,230.89	923.17	....
Repairs	18,685.01	15,882.26	14,079.07
Enginehouse:			
Labor	19,168.03	19,168.03	11,596.66
Supplies	1,165.52	1,165.52	769.30
Lubricants	828.75	828.75	1,956.00
Other supplies	376.34	376.34	376.34
Total	$217,973.96	$204,276.55	$133,979.32
Savings over old steam	....	$13,697.41	$83,994.64
Savings over new steam	....	....	70,297.23

Discussion of Empirical Data

It is a surprising fact that of all the data and figures used in the engineering of Diesel motive power, electrical equipment characteristics alone permit of prognostication of the performance with a reasonable degree of certainty. Engines, radiation, lubricating oil characteristics, mechanical designs, ventilation, application to specific or general services, and economic studies all involve many variables and incalculable factors which experience alone can solve.

It has been pointed out that train resistance values and constants are a result of experience. It may also be noted that with a side or quartering wind the flange resistance will change materially, and that type of journal bearings, shape of cars, barometric pressure and many other factors alter the resistance to movement. It is probable that no formula will ever be developed to account for all of these varying factors, and were such a formula derived it would be too complicated to be of commercial value.

The determination of steam locomotive speed-tractive force characteristics is essential in comparing the relative performance of steam and Diesel motive power. In order to calculate such a curve, the following must be assumed: 55 pounds of water are evaporated per hour for every square foot of direct heating surface; 8 to 13 pounds of water are evaporated per hour for every square foot of tube and flue heating surface; 15.25 to 35 pounds of steam per hour generate one horsepower-hour, depending upon boiler pressure and degree of superheat. These figures assume ideal conditions of firing, correct adjustment of cutoff, clean tubes and flues, and represent optimum performance. Actually, the road performance may be anywhere from 65 to 90 per cent of this. The proper performance to be assumed, then, in making a comparison is a matter of judgment, but is normally assumed to be 75 per cent of the theoretical curve, with the low speed operating range discounted even more than this.

In studying a profile to determine the "equivalent" grade for any zone of operation, it has been shown that we add the rises in feet and subtract half of the falls in feet in order to obtain an equivalent total rise. This is purely empirical and represents values which have been found reasonable to permit a close prognostication of a schedule. It may be readily seen that if all of the station stops happen to be located at the bottom of the grades so that advantage may not be taken of the accumulated momentum, or if speed is restricted on the down grade portions of the run, the assistance of these down grade sections in getting over the profile may be negligible and the equivalent grade will be higher. On the other hand, other profiles may permit full use of these descending grades and the equivalent grade lowered. This requires judgment and experience.

In considering the performance of a locomotive on varying grades, the transition of the train from one grade to the other is gradual and the rate of transition depends upon the length of the train and its speed. It has been found expedient to consider such trains as being concentrated at a single point, and only in special cases are the calculations based upon this gradual transition.

As has been pointed out earlier in this paper, the short-time thermal characteristics of electrical equipment are not well known, due to the commercial urge of quick production at limited expense. Road experience has been found to be of considerable value in determining motor and generator sizes suitable for the extremely variable conditions met in railway service. As an example of this, it has been found that for general railroad switching work it is necessary to apply motors having a continuous rating of 225 lb. per ton of locomotive weight in order to be large enough to handle the peak demands encountered. If motor developments of the future improve the ratio of continuous rating to short-time rating, then it will be necessary to revise this figure of 225 lb. per ton.

In the manufacture of Diesel railway equipment, most of the work is of a mechanical nature, even in the electrical equipment. It is surprising to an electrical engineer to find how inexact are some of the data and knowledge used in such mechanical designs. Allowable stresses, physical characteristics of materials, clearances, finishes, growing of castings, and similar necessary design information are frequently guessed and then proved out by actual road operation.

Possibilities of Further Technical Development

It is possible to look forward to considerable improvement in design, methods, and materials which enter into the design of Diesel motive power. The progress of this art will be accelerated by developing more power from a given engine, lower cost of engines, smaller electrical transmission equipment, lower transmission cost and such economic improvements. The method of obtaining these improvements is not known at this time or such developments would be under way. It is possible to visualize many advances, such as a lower resistance-conducting medium, better properties of magnetic materials, higher engine speed, etc. There are many minds working on these problems, and out of this will undoubtedly come ideas of considerable value.

Designing for

High-Tensile Steels*

By H. M. Priest†

Comparisons of weight, strength and deflection characteristics of high-tensile-steel and carbon-steel structures. Method for cost comparisons is also suggested

Bending

The stress due to bending moment is given by the fundamental equation:

$$f = \frac{M}{S} \quad \text{(5)}$$

in which

f = Unit stress, lb. per sq. in.
M = Moment, in.-lb.
S = Section modulus, in.[3]

In comparing two designs for the same bending moment, $f_1 S_1 = f_2 S_2$, from which is readily derived the relation:

$$S_2 = \frac{f_1}{f_2} S_1 \quad \text{(6)}$$

The ratio of f_1/f_2 may be obtained from the nomograph in Fig. 1.

Let the cross-section of a plate, subjected to bending, be that shown in Fig. 5(a).

$$I = \frac{bt^3}{12} \quad \text{(7)}$$

$$S = \frac{bt^2}{6} \quad \text{(8)}$$

Keeping b constant and combining equations (6) and (8),

$$t_2 = \sqrt{\frac{f_1}{f_2}} \times t_1 \quad \text{(9)}$$

The nomograph in Fig. 6 gives the graphical solution of the ratio under the radical. A few values are given in Table VII.

Table VII—$\sqrt{\dfrac{f_1}{f_2}}$

f_2	$f_1 = 16{,}000$	$f_1 = 18{,}000$
21,000	.873	.926
24,000	.816	.866
25,000	.800	.848
26,000	.784	.832
27,000	.770	.816
28,000	.756	.802
29,000	.743	.788
30,000	.730	.775

As an example, it is seen that the use of a unit stress of $f_2 = 24{,}000$ lb. per sq. in. requires a thickness of plate equal to .816 of that with a unit stress of $f_1 = 16{,}000$ lb. per sq. in. This effects a reduction of 18.4 per cent in the thickness and consequently the same reduction in the weight of steel required.

Another case of bending on a plate is that of the cross-section in Fig. 5(b).

$$I = \frac{bd^3}{12} \quad \text{(10)}$$

$$S = \frac{bd^2}{6} \quad \text{(11)}$$

Combining equations (6) and (11), with depth d constant:

$$b_2 = \frac{f_1}{f_2} b_1 \quad \text{(12)}$$

Reference may be made to Fig. 1 for values of the ratio f_1/f_2.

An interesting and practical question arises as to the effect of increased unit stresses upon the area of the flanges of beams and girders. Two typical flanges are shown in Fig. 5(c). Let

A = Area of one flange, sq. in.
d = Distance between centers of gravity of flanges, in.
f = Unit stress in the flanges, lb. per sq. in.
M = Moment carried by the flanges, in.-lb.

Then

$$A = \frac{M}{fd} \quad \text{(13)}$$

For the basic and new designs respectively:

$$A_1 = \frac{M}{f_1 d_1}, \text{ and } A_2 = \frac{M}{f_2 d_2}$$

Assuming that

$$d_1 = d_2$$

$$A_2 = \frac{f_1}{f_2} \times A_1 \quad \text{(14)}$$

It will be observed that this equation is the same as Equation (2) for tension members and the ratio may be solved by means of the nomograph in Fig. 1.

If the plate of Fig. 5(b) is combined with the flanges

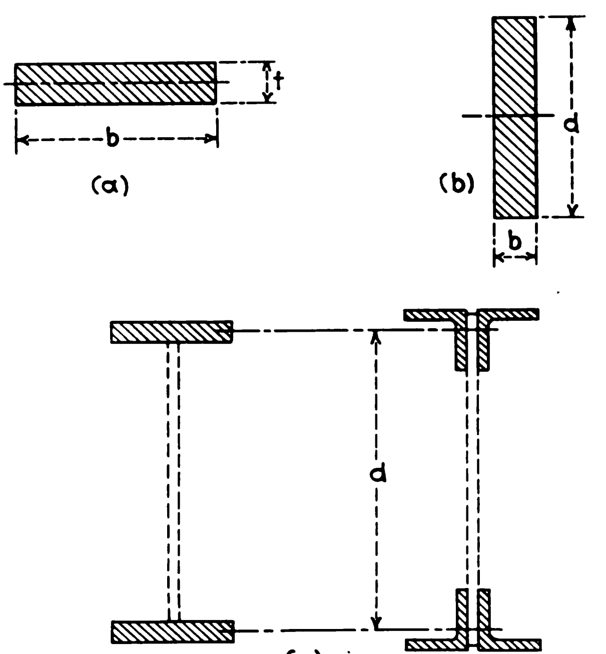


Fig. 5—Sections resisting bending stresses

* Part I of this article appeared in the May issue of the *Railway Mechanical Engineer*, page 179.
† Engineer, Railroad Research Bureau, United States Steel Corporation Subsidiaries, Pittsburgh, Pa.

of Fig. 5(c) to form a plate girder it will be seen from a consideration of Equations 12 and 14 that, with a constant depth, the total areas are related by the equation, $A_2 = f_1/f_2 \times A_1$. The saving in weight of the beam or girder, as represented by this equation, may be said to be the maximum possible, for the reason that other considerations, such as web crippling, shear and

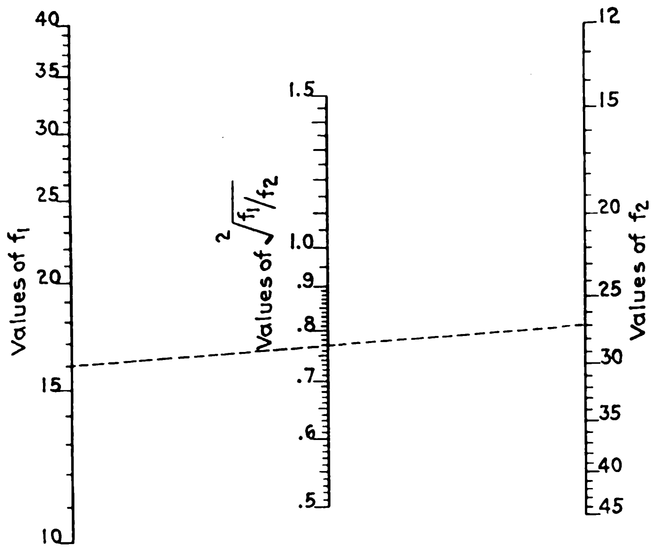


Fig. 6—Ratio of $\sqrt{\frac{f_1}{f_2}}$

lateral buckling may limit the reductions or add weight in the form of stiffeners which will offset some of the saving indicated. These factors will be treated more fully in a later portion of this paper.

A study of weights of wide flanged beams (CB Beams) was made by first selecting the minimum weight of beams required for each of 74 different values of section modulus, ranging in value from 20.0 to 704.5, each value being 5 per cent greater than the preceding one. With these values equal to S_1 in Equation (6), the values of S_2 were calculated for several ratios of f_1/f_2 for which the most economical weights of beams were selected. The comparison of weights is given in Table VIII.

Table VIII

Ratio $\frac{f_1}{f_2}$	Ratio of weights
1.00	1.000
.90	.934
.80	.865
.70	.796
.667	.771
.60	.720
.50	.643

The ratio of weights is very closely represented by the formula

$$\text{Ratio} = .70 \frac{f_1}{f_2} + .30 \qquad (15)$$

An example will illustrate the use of this formula. Assume that the saving in weight of beams is desired when the working unit stress is raised from 16,000 to 24,000 lb. per sq. in. The ratio of weights equals $.70 \left[\frac{16{,}000}{24{,}000}\right] + .30 = .767$, showing an average saving of 23.3 per cent.

It is possible to obtain a greater saving for the cases shown in Figs. 5(a), 5(b) and 5(c) by corrugating the sheet or plate in the first case and by increasing the depth d for the last two cases. These methods of securing weight reduction are applicable to the basic design as well as to the new design, but they should not be overlooked when making a study of possible weight economies.

The reduction in thickness of the web of a beam or plate girder designed for high-tensile steel makes it necessary to give special attention to this feature. In a paper entitled Stability of the Web of Plate Girders,[5] by S. Timoshenko, there is an excellent discussion of the problem.

Table IX—Limiting Values of $\frac{h}{t}$

Tension yield point, lb. per sq. in.	Shearing yield point, lb. per sq. in.	Max. $\frac{h}{t}$
29,000	18,000	88.2
33,000	21,000	81.7
45,000	29,000	69.5
50,000	33,000	65.1
55,000	37,000	61.5

A further discussion of this paper by O. E. Hovey appeared in Bulletin 374 of the American Railway Engineering Association for February, 1935, in which modifications are suggested to bring the formulae and tables of the paper into more convenient form.

Two conditions of stress are considered: one, a rectangular plate subjected to pure shear, as at the ends of a girder; the other, that of a rectangular plate subjected to bending, as at the center of a girder. S. Timoshenko shows that the critical shearing stress for a web without stiffeners has the value

Table X—Maximum Values of $\frac{h}{t}$

Tensional yield point, lb. per sq. in.	Values of $\frac{h}{t}$
29,000	182.1
33,000	170.7
45,000	146.1
50,000	138.6
55,000	132.2

$$S_{cr} = 4.83\, E \frac{t^2}{h^2} = F\, S \qquad (16)$$

from which the limiting maximum values of h/t are given by the formula

$$\frac{h}{t} = \sqrt{\frac{4.83E}{S_{cr}}} = \sqrt{\frac{4.83E}{FS}} \qquad (17)$$

S_{cr} = Critical unit shearing stress, lb. per sq. in.
h = Clear distance between flanges, in.
t = Thickness of web, in.
S = Working unit shearing stress, lb. per sq. in.
F = Factor of safety.

The results of tests show shearing yield points approximately as given in Table IX from which values of h/t have been calculated from Equation (17).

These limiting values are those for unstiffened webs with the maximum unit shearing stresses. The specifications of both the American Railway Engineering Association and the American Institute of Steel Construc-

[5] Presented at the Semi-Annual Meeting of the American Society of Civil Engineers and the American Society of Mechanical Engineers, Chicago, Ill., June 26-30, 1933, at a joint session of the A. S. C. E. Structural Division and the A. S. M. E. Applied Mechanics Division.

[6] The general formula for the spacing of stiffeners is

$$d = \frac{381{,}700}{fS}\, t \sqrt{\frac{fSt}{a}}$$

in which f = factor of safety. In equation (18) a factor of safety equal to 1.833 was used, but any other value may be substituted in the general formula.

tion contain the following type of clause for carbon steel of structural grade, (quoted from the A.R.E.A. Specifications for Steel Railway Bridges):

If the depth of the web between the flanges or side plates of a plate girder exceeds 60 times its thickness, it shall be stiffened by pairs of angles riveted to the web.

Similarly, for alloy steels with tension yield points of 45,000 and 50,000 lb. per sq. in., the A.R.E.A. Specifications require stiffeners when the ratio of the clear depth to thickness of the web exceeds 50 times the thickness.

The spacing of stiffeners may be obtained from the formula[6]:

$$d = \frac{255{,}000}{S}\, t \sqrt{\frac{St}{a}} \qquad (18)$$

S = Unit shearing stress on gross section of web at point considered.
t = Thickness of web.
a = Clear distance between flanges.
d = Clear distance between stiffeners.

Equation (18) is applicable to steel of various grades. The dimensions are clearly illustrated in Fig. 7(a).

The minimum thickness of web is usually determined by the conditions prevailing near the center of the girder span where the web is subjected to the maximum mo-

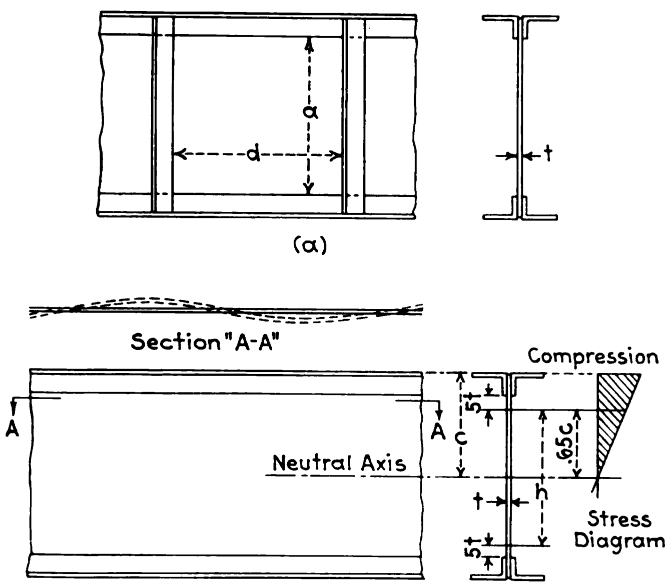


Fig. 7—Stability of girder web plates

ment. The web, just inside the compression flange of the girder shown in Fig. 7(b) is under a large compressive stress and tends to buckle as illustrated in Section AA. The critical buckling unit stress is given by the following formula in the paper on web stability by S. Timoshenko:

$$S_{cr} = K \frac{E}{1 - m^2} \frac{t^2}{h^2} \qquad (19)$$

S_{cr} = Critical buckling unit stress, lb. per sq. in.
K = Constant
E = Modulus of elasticity, lb. per sq. in.
m = Poisson's Ratio
t = Thickness of web, in.
h = Clear distance between flanges, in.

Letting S_{cr} = Tensional yield-point stress, $K = 19.7$, $m = 0.30$ and $E = 29{,}000{,}000$ and solving for h/t,

$$\frac{h}{t} = \frac{25{,}000}{\sqrt{YP.}} \qquad (20)$$

O. E. Hovey made a study of railway plate girders in which he assumed that the flanges supported the web for a distance from the flanges equal to five times the thickness of the web—see Fig. 7(b). He found that this point is about 0.65 of the total distance from the neutral axis to the extreme fibre of the flange. Hence the compressive stress at this point is 0.65 of the maximum stress. With the maximum stress equal to the tensional yield-point stress, the critical stress in Equations (19) and (20) may be placed equal to 0.65 times the yield point, resulting in the formula:

$$\frac{h}{t} = \frac{25{,}000}{\sqrt{.65YP.}} = \frac{31{,}000}{\sqrt{YP.}} \qquad (21)$$

Equation (21) yields the values of h/t for several different yield points given in Table X.

It is readily seen that the high-tensile steels have lower limiting values for the ratio, h/t, than that for carbon steel. When necessary, the web may be strengthened by means of horizontal stiffeners but this is apt to be a rather expensive method and the less costly way may be that of increasing the web thickness to meet the requirements in Table X.

It should be remembered that the buckling of a girder web does not necessarily mean failure of the web. The diagonal tension in the web and the compression in the vertical stiffeners or struts will transform the action of the girder into one analogous to that of a Pratt truss. Girders may be designed upon this basis, as is sometimes done in metal airplane construction, but especial attention must be given to the flanges and their connection to the web in order to provide properly for the bending of the flanges between the stiffeners.

When the compression flange of a beam or girder is unsupported laterally it is necessary to decrease the allowable unit stress in order to prevent the flange from buckling in much the same manner as a column. This is not a subject which lends itself readily to exact analysis, nor are there many test data against which to check any theoretical formulae. It was shown in the section of this paper dealing with compression that a theoretical analysis of a compression member leads to the secant formula. This same method of analysis will be applied to the problem of compression flanges.

The general formula for the working unit stress in compression may be written as follows:

$$\frac{P}{A} = \frac{\dfrac{\text{Yield Point}}{m}}{1 + a \sec \sqrt{\dfrac{mP}{AE}} \left[\dfrac{L'}{2r}\right]} \qquad (22)$$

in which m = factor of safety and the other terms are as previously noted. In order to reduce this formula to workable form it is necessary to assign values to the several terms.

The factor of safety will be taken between values of 1.81 and 1.87, varied slightly for the several yield points in order to bring the numerator of the right-hand member of the equation into round thousands of pounds per square inch:

Yield point, lb. per sq. in.	Factor of safety	Unit stress, lb. per sq. in.
29,000	1.813	16,000
33,000	1.833	18,000
45,000	1.875	24,000
50,000	1.852	27,000
55,000	1.833	30,000

Existing formulae for compression flanges generally use the ratio of unsupported length to width of flange, L/b, instead of the familiar ratio of L/r for columns and compression members. A study of beam and girder flanges indicates that for a general average the lateral

radius of gyration may be taken as equal to 0.25 of the width of the flanges, i.e., $r = .25b$.

The formula to be derived will be based upon uniformly loaded beams and girders of simple span with flanges unsupported between vertical supports. For this condition of loading the effective length of the flange, acting as a column, may be taken as 0.694 times the total length; that is, $L' = 0.694L$.

The remaining term of the formula which must be given a value is a, the eccentric ratio. A reasonable value for this term is $.005L/b$. When $L/b = 0$, the value of P/A equals the unit stress obtained by dividing the yield point by the factor of safety. The usual maximum limit for L/b is taken at 40, at which value a would equal 0.20. This is somewhat under the value of 0.25 recommended for columns by the A.S.C.E. Special Committee on Steel Column Research, and in view of the existence of some lateral support in every beam or girder, the assumption of $.005L/b$ for the eccentric ratio is a reasonable one.

Assembling these terms and placing them in Equation (22) there is obtained

$$\frac{P}{A} = \frac{\dfrac{\text{Yield Point}}{m}}{1 + .055\dfrac{L}{b}\sec\sqrt{\dfrac{mP}{AE}}\left[\dfrac{.694L}{.25b}\right]}$$

A reference to Fig. 3 shows that the curve plotted for the secant formula reverses from a curvature convex upward to convex downward. For the above formula the point of reversal of curvature occurs in the vicinity of $L/b = 40$ for yield points of 29,000 and 33,000 lb. per sq. in. and of $L/b = 35$ for the yield points of 45,000, 50,000 and 55,000 lb. per sq. in. These limits for L/b will be used, within which the formulae will be applicable.

As an example, let us take the case of the yield point equal to 33,000 lb. per sq. in. and the factor of safety equal to 1.833. Let the modulus of elasticity equal 29,400,000 lb. per sq. in.

$$\frac{P}{A} = \frac{18{,}000}{1 + .005\dfrac{L}{b}\sec\sqrt{\dfrac{1.833}{29{,}400{,}000}\dfrac{P}{A}}\left[\dfrac{.694L}{.25b}\right]} \qquad (23)$$

This is a complicated formula from which to obtain the value of P/A and, as in the case of column formulae, a simple parabolic formula can be substituted for the portion of the secant curve which lies between $L/b = 0$ and the maximum limit previously mentioned. In this example such a parabolic formula is:

$$\frac{P}{A} = 18{,}000 - 5.34\left[\frac{L}{b}\right]^2$$

Table XI—Allowable Compressive Unit Stresses—Unsupported Flanges

Yield point, lb. per sq. in.	$\frac{P}{A}$	Range for $\frac{L}{b}$
29,000	$16{,}000 - 4.36\left[\frac{L}{b}\right]^2$	0 — 40
33,000	$18{,}000 - 5.34\left[\frac{L}{b}\right]^2$	0 — 40
45,000	$24{,}000 - 9.31\left[\frac{L}{b}\right]^2$	0 — 35
50,000	$27{,}000 - 11.25\left[\frac{L}{b}\right]^2$	0 — 35
55,000	$30{,}000 - 13.27\left[\frac{L}{b}\right]^2$	0 — 35

Similarly, for a few other values of the yield point, the parabolic formulae are given in Table XI.

The values given by these various formulae are plotted in Fig. 8. The curves for yield points of 45,000, 50,000 and 55,000 lb. per sq. in. have been extended to $L/b = 40$, as shown by the dotted lines. At this point, the values for P/A derived from the respective secant formulae are 10,260, 10,670 and 11,010.

Deflection

Structures fabricated with high-tensile steels may show greater deflection than those designed with ordinary carbon steel of structural grade. This condition arises from the fact that the modulus of elasticity, E, is practically constant for all grades of steel. There are some cases in which deflection is of vital importance and must be kept within specified limits, thus precluding the possibility of any weight reduction in the members. On the other hand, there are many instances when advantage can well be taken of the weight reduction effected by high-tensile steels, even though the deflection may be increased.

The deflection of a simply supported beam under a uniform load is given by the expression:

$$y = \frac{5WL^3}{384\,EI} \qquad (24)$$

W = Total load, lb.
L = Span, in.
y = Deflection, in.
E = Modulus of elasticity, lb. per. sq. in.
I = Moment of intertia, in.

Let I_1 and I_2 be the moments of inertia and y_1 and y_2 the deflections of beams designed for fibre stresses in bending of f_1 and f_2, respectively.

$$y_1 = \frac{5WL^3}{384EI_1}$$

$$y_2 = \frac{5WL^3}{384\,EI_2}$$

Then

$$\frac{y_2}{y_1} = \frac{I_1}{I_2} \qquad (25)$$

With beams of equal depth, $S_1/S_2 = I_1/I_2$ and it was shown in Equation (6) that $S_1/S_2 = f_2/f_1$, hence $y_2/y_1 = f_2/f_1$, or

$$y_2 = \frac{f_2}{f_1}\,y_1 \qquad (26)$$

Equation (26) applies to other types of loading on the same span since the deflection formulae are of the form, $y = \dfrac{\text{Constant}}{I}$. In Table XII are given a few values of the ratio, f_2/f_1.

By a simple transformation, the deflection formula of Equation (24) may be expressed in the following terms:

$$y = \frac{5fL^2}{24Ed} \qquad (27)$$

f = Unit stress in bending, lb. per sq. in.
d = Depth of beam or girder, in.

Equations (24) and (27) show that decreases in deflection can be brought about by any of the methods listed below:

1—Decrease the load W (equivalent to reducing the moment).

2—Decrease the span L.

3—Increase the depth d.

An additional method is that of introducing restraining moments at the ends of the span, such as those over the supports of a continuous beam.

It may seldom be necessary to resort to any of these changes but they are the available avenues of reducing deflection when required.

Table XII—Values of $\frac{f_2}{f_1}$

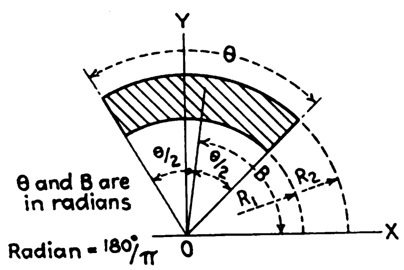
f_1	f_2	$\frac{f_2}{f_1}$
16,000	24,000	1.50
16,000	27,000	1.69
16,000	30,000	1.88
18,000	24,000	1.33
18,000	27,000	1.50
18,000	30,000	1.67

Pressed Shapes

The reductions in thickness of material made possible by the high-tensile steels often bring the required sections below the minimum thicknesses of standard rolled shapes. In such cases there is often an advantage to be gained by pressing and forming shapes from strip, sheets or plates. The designer has a wide latitude and may "tailor-make" the pressed shapes to fit his particular construction. No handbook of properties for such sections is available and individual calculations have to be made for each one.

All pressed sections have fillets or rounded corners wherever there is an angular change in the direction of the surface. The determination of the properties of a section may be simplified by the use of the properties of fillets shown in Table XIII. The first group of formulae apply to the general case and will be found useful for irregular sections. The right-angle fillets of the second group are of much more frequent occurrence and the properties have been tabulated for three different values of the inside radius of curvature. Tables similar to those of Tables XIII(a) and XIII(b) can be prepared easily for various thicknesses and radii of fillets, thus making a tabulation of more immediate value. The moments of inertia of rectangles about axes other than the principal axes, are sometimes required and the formulae for such cases are given at the right Table XIII.

Table XIII—Properties of Fillets

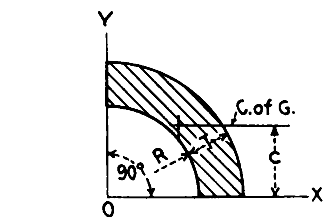


$$\text{Area} = \theta/2\ (R^2_2 - R^2_1)$$

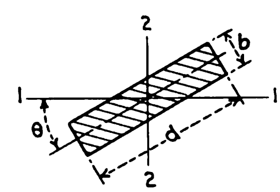
$$M_x = \frac{R^3_2 - R^3_1}{3}\left(2 \sin \frac{\theta}{2} \sin B\right)$$

$$I_x = \frac{R^4_2 - R^4_1}{8}(\theta - \cos 2B \sin \theta)$$

Attention should be paid to the signs of the sines and cosines.



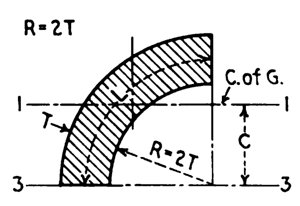
Property	R = T	R = 2T	R = 3T
Area, sq. in.	$\frac{3\pi T^2}{4}$	$\frac{5\pi T^2}{4}$	$\frac{7\pi T^2}{4}$
M_x	$\frac{7T^3}{3}$	$\frac{19T^3}{3}$	$\frac{37T^3}{3}$
I_x	$\frac{15\pi T^4}{16}$	$\frac{65\pi T^4}{16}$	$\frac{175\pi T^4}{16}$
$c = \frac{M_x}{A}$	$\frac{28T}{9\pi}$	$\frac{76T}{15\pi}$	$\frac{148T}{21\pi}$



$$I_{1-1} = \frac{bd^3 \sin^2\theta}{12} + \frac{b^3d \cos^2\theta}{12}$$

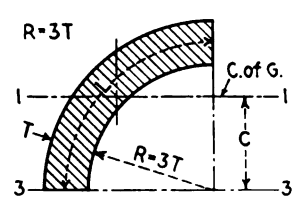
$$I_{2-2} = \frac{bd^3 \cos^2\theta}{12} + \frac{b^3d \sin^2\theta}{12}$$

Table XIII(a)—Numerical Values of Properties of Fillets, R = 2T



T, in.	L, in.	Area, sq. in.	C, in.	M_{3-3}	I_{3-3}	I_{1-1}
1/16	.2454	.0153	.1008	.00155	.000195	.0000389
3/32	.3682	.0345	.1512	.00522	.000986	.0001969
1/8	.4909	.0614	.2016	.01237	.003116	.0006222
5/32	.6136	.0959	.2520	.02416	.007607	.001519
3/16	.7363	.1381	.3023	.04175	.015774	.003150
7/32	.8590	.1879	.3527	.06629	.029224	.005836
1/4	.9817	.2454	.4031	.09896	.049854	.009955
9/32	1.1045	.3106	.4535	.1409	.079857	.01595
5/16	1.2272	.3835	.5039	.1933	.12172	.02431
11/32	1.3499	.4640	.5543	.2573	.17820	.03559
3/8	1.4726	.5522	.6047	.3340	.25239	.05040
13/32	1.5953	.6481	.6551	.4246	.34763	.06942
7/16	1.7181	.7517	.7055	.5304	.46758	.09337
15/32	1.8408	.8629	.7559	.6523	.61618	.12304
1/2	1.9635	.9817	.8063	.7917	.79767	.15929
17/32	2.0862	1.1083	.8566	.9496	1.0166	.2030
9/16	2.2089	1.2425	.9070	1.1272	1.2777	.2551
19/32	2.3317	1.3844	.9574	1.3257	1.5862	.3167
5/8	2.4544	1.5340	1.0078	1.5462	1.9474	.3889

Table XIII(b)—Numerical Values of Properties of Fillets, R = 3T



T, in.	L, in.	Area, sq. in.	C, in.	M_{3-3}	I_{3-3}	I_{1-1}
1/16	.3436	.0215	.1402	.0030	.000524	.000102
3/32	.5154	.0483	.2103	.0102	.002654	.000517
1/8	.6872	.0859	.2804	.0241	.008389	.001634
5/32	.8590	.1342	.3505	.0471	.020481	.003990
3/16	1.0308	.1933	.4206	.0813	.042469	.008273
7/32	1.2026	.2631	.4907	.1291	.078679	.015327
1/4	1.3744	.3436	.5608	.1927	.134223	.026146
9/32	1.5463	.4349	.6309	.2744	.21500	.04188
5/16	1.7181	.5369	.7010	.3764	.32769	.06383
11/32	1.8899	.6496	.7711	.5010	.47978	.09346
3/8	2.0617	.7731	.8412	.6504	.67951	.13237
13/32	2.2335	.9073	.9114	.8269	.93593	.18232
7/16	2.4053	1.0523	.9815	1.0328	1.25887	.24522
15/32	2.5771	1.2080	1.0516	1.2703	1.65895	.32316
1/2	2.7489	1.3744	1.1217	1.5417	2.14757	.41834
17/32	2.9207	1.5516	1.1918	1.8492	2.7369	.5331
9/16	3.0925	1.7395	1.2619	2.1951	3.4400	.6701
19/32	3.2643	1.9382	1.3320	2.5816	4.2705	.8319
5/8	3.4361	2.1476	1.4021	3.0111	5.2431	1.0213

Cost Comparisons

No study of light-weight construction would be complete without a comparison of costs with those prevailing for designs using ordinary structural carbon steel. In some instances the cost may be increased by the high-tensile steels but compensating advantages will be found in the items of operating and maintenance costs and often in increased revenue which may result from the increased pay-load capacity. The nomographic chart in Fig. 9 provides a ready means of making rapid studies of the relation between weights to give equal costs of material for two differently priced steels.

For the purposes of illustration, assume a structure to be fabricated with a grade of steel costing 1.90 cents per pound and that the total weight is W_1 pounds. Let it be required to find the weight of steel in a new design in which a high-tensile steel costing 2.80 cents per

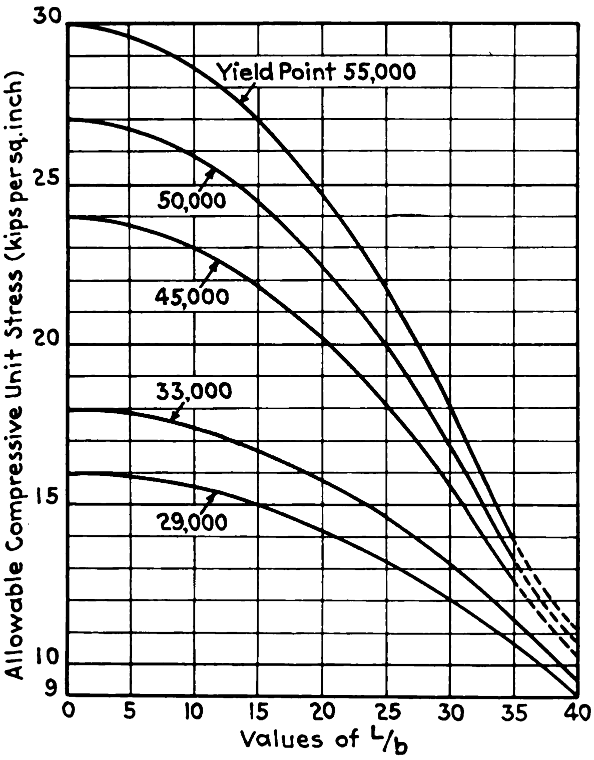
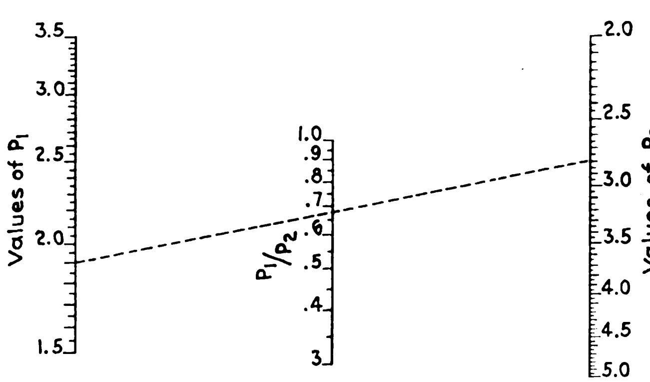


Fig. 8—Allowable compressive stresses for laterally unsupported compression flanges



P_1 = Price (cts. per lb.) of steel in basic design
P_2 = Price (cts. per lb.) of steel in new design
W_1 = Weight of steel in basic design
W_2 = Weight of steel in new design
For equal costs, $P_1 W_1 = P_2 W_2$
$W_2 = (P_1/P_2) W_1$

Fig. 9—Ratio of weights for equal total costs

pound, is to be used. In this example $P_1 = 1.90$ and $P_2 = 2.80$ and by laying a straight edge across the diagram connecting these respective values, we read on the middle vertical scale the value of $P_1/P_2 = 0.68$. Therefore the weight of the structure with high-tensile steel should not exceed 68 per cent of the original weight, W_1, in order that the total cost of material shall not be greater than that with the cheaper steel.

With this ratio of weights it becomes possible to determine in a preliminary way the physical requirements of the high-tensile steel to meet these conditions. Assume the first structure, with the 1.90-cent steel, to have been designed with a working unit stress in tension of 16,000 lb. per sq. in. Referring to the chart in Fig. 1, lay a straight edge across the diagram connecting $f_1 = 18{,}000$ and $f_1/f_2 = P_1/P_2 = 0.68$ and where it crosses the right-hand vertical scale read 23,500 for f_2. This is the necessary working unit stress for the high-tensile steel and from Table II it will be seen that this corresponds to a steel having a yield-point strength of about 45,000 lb. per sq. in.

There are other problems which will be encountered in the study of the application of high-tensile steels but it is hoped that the discussion in this paper will prove of definite assistance to those who are concerned with such investigations.

New High-Tensile Steel

To meet an increasing demand for a special high-tensile steel, Armco HT-50 has been developed by the American Rolling Mill Company, Middletown, Ohio.

Tests on specimens show the impact tensile strength is 5,000 lb. per sq. in., nearly double that of mild steel. but care has been taken to avoid strength in excess of actual requirements. This permits the use of advanced methods of fabrication and welding. Armco HT-50 has a sufficiently high yield point to be used on jobs with the highest practical stresses, but still maintains sufficient ductility to be adaptable for varied fabrication.

While the endurance limit of Armco HT-50 is 48,000 lb. per sq. in., the yield point is 47,000 lb. per sq. in. in the hot rolled grades. Few materials offer an endurance limit equal to or greater than the yield point. Tensile strength is 67,000 lb. per sq. in. in the hot rolled grades and 70,000 lb. in cold rolled. Elongation in two inches is 28 per cent in hot rolled sheets.

Because welding is now an accepted method in the assembly of structures that will be moved continually at high or low speeds, the carbon is confined to a very low percentage, strength being obtained by other additions. Finished welds closely approach the unwelded parts in physical properties. Sheets and plates can be welded with many varieties of the so-called shielded arc electrodes.

Atmospheric corrosion resistance of Armco HT-50 is said to be four to six times that of ordinary steel. Sheets and plates are offered in 20-gage and heavier, in all finishes and sizes ordinarily supplied in mild steel, hot and cold rolled grades.

Another Record.—To the French railways goes a record of which they can hardly be proud. In a recent boiler explosion on the locomotive of a passenger train at Tenay-Hautville, the running gear was left on the track, while the rest of the engine was blown into a cornfield exactly 1,738 ft. away. This must be a long distance record for boiler explosions.

Failures of

Locomotive Parts*

By F. H. Williams†

FAILURES of side rods in service, or the scrapping of such rods because of cracks discovered by vigilant inspectors, are sometimes occasioned by holes in ends of the rods that, for one reason or another, are not now required and which are usually plugged. A typical hole of this sort is shown in the drawing. The stop plugs were formerly placed at the bottom of the rod, but the projecting plug prevented the rods from being stood on their edges in the shop, and the plug was transferred to the top in connection with the oil or grease cup. In general the failures are caused by cracks which start from:

1—A hole which has been drilled and tapped, but is not now required, and is left open.

2—A hole filled with a steel plug, which is held in place by welding.

3—A hole filled with a plug, which is trimmed off and is held in place by being peened over with a hammer.

Here, as in the type of failures which was described in the article in the *Railway Mechanical Engineer* of May, 1936, page 190, fatigue cracks are started from what may appear to be insignificant details. The metal may be slightly torn by the finishing tool in machining, or the sharp edges of the hole may not be properly rounded. The condition is, of course, aggravated in the case of side rods, which are subjected to severe alternating stresses.

"Do you want a microscopic finish?" I have been asked. We do want the finest finish that can reasonably be obtained. If we find that a number of failures result from what we consider a standard finish, then it is evident that steps must be taken to insure a higher and better standard. Something is surely wrong when it is found that fatigue cracks almost universally start from places which are clearly indicated by the tool marks to be rough finished.

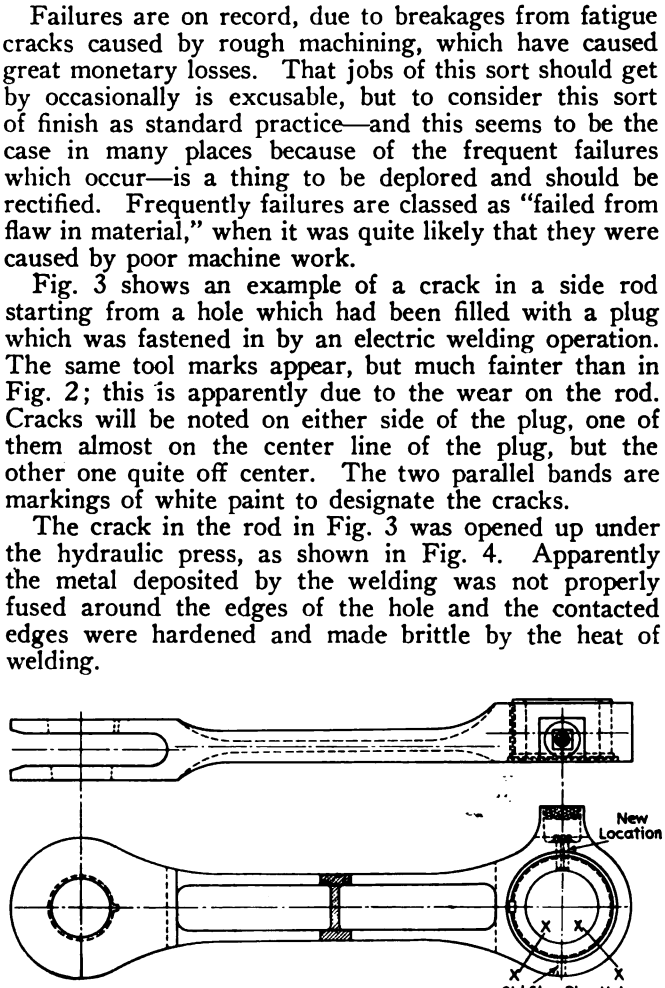
The illustrations which accompany this article emphasize the point that I am trying to make. Fig. 1 illustrates the side view of a section at the end of the side rod, which was removed because of a crack discovered by an inspector. This photograph does not show the crack, which started on the inside near the center of the segment. The punch marks to the right of the letter *E* are markings which have no relationship at all to the failure. The photograph is used merely to give an idea of the shape and size of the section of the rod where the crack started. The exact location of this section is shown on the drawing between the X-X lines.

The crack on the inside of the eye of the rod is not very clearly defined but appears as a white streak about midway between the parallel chalk marks designated by the arrows in Fig. 2. Here the crack was apparently caused by a combination of a sharp edge in the plugged hole and rough finish of a diamond pointed boring tool. One indication of this is that the crack is a little to the left of the center of the plugged hole, where the thickness of the section is slightly greater than through the center. There may be some question as to the rough finish starting this crack, because it is at right angles to the tool marks. A microscopic examination, however, would indicate that the metal was torn at the edge of the hole in which the plug was fitted, thus causing a slight defect from which the fatigue crack started. In this particular case the original plug was loosened; it was removed and the hole was filled by the electric welding process. It was then retapped for the plug, although this is indicated only slightly in the photograph by the traces of an inner circle.

Failures are on record, due to breakages from fatigue cracks caused by rough machining, which have caused great monetary losses. That jobs of this sort should get by occasionally is excusable, but to consider this sort of finish as standard practice—and this seems to be the case in many places because of the frequent failures which occur—is a thing to be deplored and should be rectified. Frequently failures are classed as "failed from flaw in material," when it was quite likely that they were caused by poor machine work.

Fig. 3 shows an example of a crack in a side rod starting from a hole which had been filled with a plug which was fastened in by an electric welding operation. The same tool marks appear, but much fainter than in Fig. 2; this is apparently due to the wear on the rod. Cracks will be noted on either side of the plug, one of them almost on the center line of the plug, but the other one quite off center. The two parallel bands are markings of white paint to designate the cracks.

The crack in the rod in Fig. 3 was opened up under the hydraulic press, as shown in Fig. 4. Apparently the metal deposited by the welding was not properly fused around the edges of the hole and the contacted edges were hardened and made brittle by the heat of welding.



Side rod showing location of old stop plug hole

The fractured parts of the rod after it was opened up by the hydraulic press are shown in Fig. 5. It will be noted that the crack on one side of the plug had not progressed to nearly the same extent as the one on the other side. Quite probably the primary crack was started on the side where the break had progressed more extensively. While the photograph does not show it clearly, a close examination of the crack indicated that it was of the fatigue variety.

Another example of a similar crack, which was discovered in time to prevent a failure in service, is shown in Fig. 6.

A typical fractured side rod through a plugged hole is shown in Fig. 7, where the fatigue cracks extend

* Part II of an article which began in the May issue.
† Assistant test engineer, Canadian National Railways.

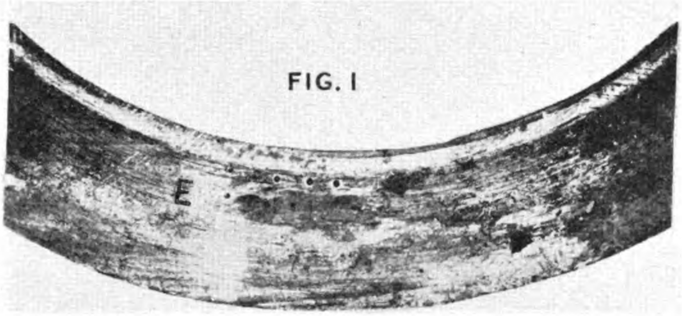


FIG. 1

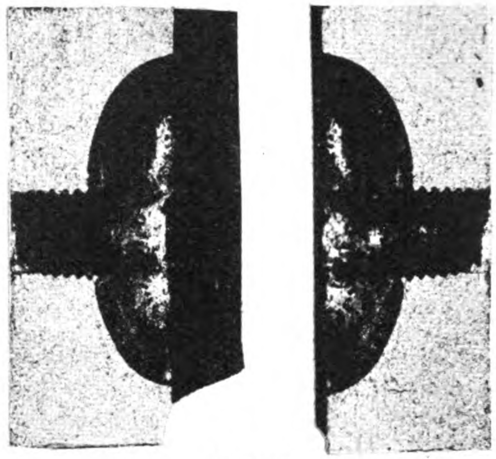


FIG. 5

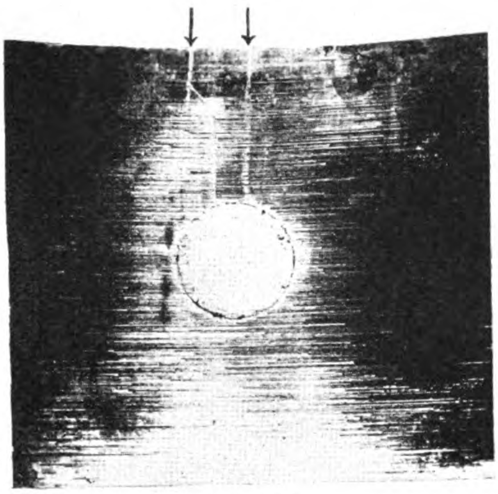


FIG. 2

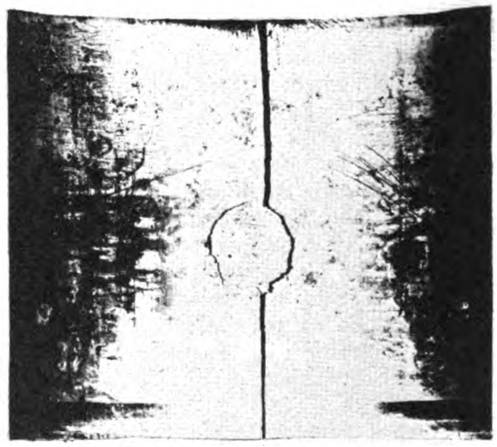


FIG. 6

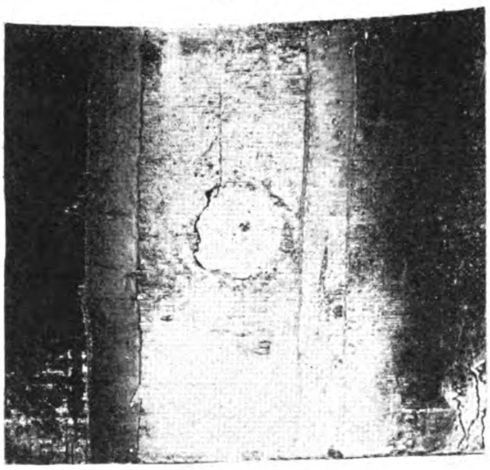


FIG. 3

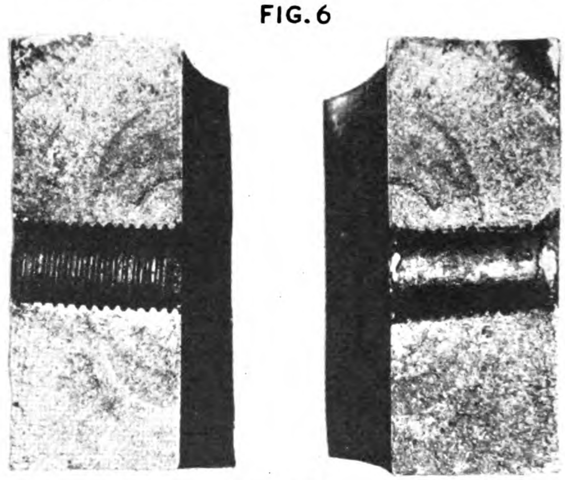


FIG. 7

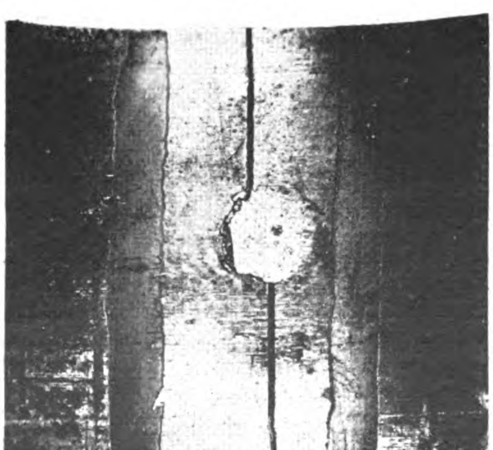


FIG. 4

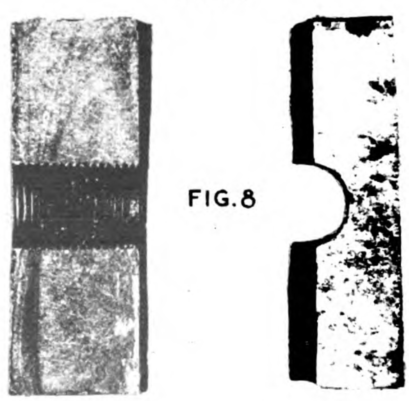


FIG. 8

Figs. 1 and 2 (left)—Section of side rod, cracked through the eye (see portion between X—X lines on drawing). Fig. 1 is reproduced simply to give some idea of the thickness of the section of the rod where it was cracked. Fig. 2 is a view of the inside of the eye, showing the marks of the cutting tool; the crack is at right angles to these marks, midway between the two chalk marks designated by the arrows. Fig. 3—View inside the eye of another cracked side rod. Fig. 4—Shows what happened when the crack in Fig. 3 was opened up by an hydraulic press. Fig. 5—Fractured parts of side rod shown in Figs. 3 and 4. The fatigue crack had extended to a considerable extent before it was discovered. Fig. 6—Another view of the inside of an eye of a side rod, with a crack which started from a stop plug hole. Fig. 7—A break caused by a fatigue crack originating at a stop plug hole and at the inside of the eye of the side rod. Fig. 8—Another typical fracture of the end of a side rod, starting from a stop plug hole; this section was somewhat thinner than the rods shown in the other illustrations.

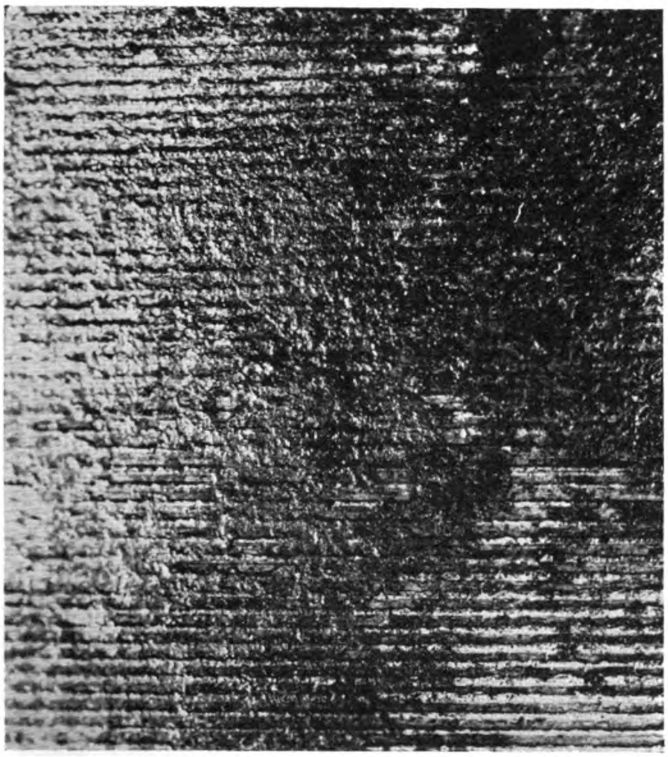


Fig. 9—Enlargement to six diameters of the surface of the bore in the eye of a side rod; about 72 threads per inch. What a menace!

across the entire section. Fig. 8 illustrates another complete fracture of a somewhat thinner section.

As indicated in the previous article in the May, 1936, *Railway Mechanical Engineer*, the fatigue crack is identified by the appearance of the fracture after the break. It progresses slowly at first (it is sometimes known as a progressive crack), the waves or markings in the fracture being close together. These gradually grow larger and rougher, until when the break occurs the fracture is quite coarse. The first waves are less than one hundredth of an inch in width, while the last ones may measure anywhere from one-quarter to an inch or more. Such fractures practically always start from the inside of the eye of the rod and work outward through the section.

The drilling of a hole through the rod leaves the edges sharp, with roughnesses that may result in the starting of fatigue cracks. The remedy is, of course, to round off these sharp edges; some railroads even insist that the surface be polished. A simple machine tool can be used for rounding the edge. Too much stress, however, cannot be placed upon the necessity of a smooth finish on all machining operations.

Fig. 9 is an excellent example of a rough finish, which is a splendid breeding place for fatigue cracks, particularly under the reverse stresses to which the side rods are subjected. Tool marks in this case are thin, about 72 per inch, and the illustration is an enlargement of about six diameters. We must face the facts and must clearly understand that even the smallest details must not be ignored in studying to find the causes of breakages.

It is indeed fortunate that most of the actual failures of side rods occur at the time the locomotive is starting, so that the damage is less serious than if it were traveling at high speed. Even at that, however, it is a costly process to replace the rods and the locomotives, which must be temporarily taken out of service until repairs can be made.

"Fine feathers make fine birds." Small things must not be ignored. Fine finishes make fine locomotives.

Evans Auto-Duplex All-Steel Car Partition

After almost a year of test service in a Great Northern box car, it is announced that the Evans Auto-Duplex all-steel car partition is now ready for production. Built by the Evans Products Company, Detroit, and distributed by Coordinated Transportation, Inc., St. Paul, Minn., this new car door, or partition, in effect makes a box car a dual purpose car. In other words, it may be used for one-way loading as a privately sealed compartment car and on the return trip as a standard box car for carload freight. The use of the partition is designed to minimize empty car mileage on unbalanced l. c. l. runs and convert many obsolete automobile cars into usable rolling stock.

The partition, which is of steel, is designed to fit cars with opposite or staggered doors. The partition folds on the diagonal, and when not in use is folded into the roof of the box car. When in place, the partition separates one end of the car from the other.

Evans all-steel car partition as applied in the test car

EDITORIALS

Oelwein Shop Improvements Produce Results

Railroad back shops differ in a number of important particulars from high-production industrial plants in which articles are manufactured at a profit for public consumption. And yet, the same main objective of maximum output per unit of cost, and many of the same general principles of operation, apply in both cases. While primarily devoted to maintenance, an analysis of the work of any major back shop will show literally hundreds of repetitive operations on small parts which are, or could be, standardized and manufactured in quantities on more or less specialized, high-production machinery. Maintenance operations on locomotive and car parts also are repeated time and again and therefore are subject to handling on a production basis.

The extent to which railroad shops can be organized and operated on this basis depends upon at least three important elements: (1) The *vision* of responsible mechanical department and shop officers; (2) their willingness to adopt, insofar as practicable, production methods successfully used in other modern railroad and industrial shops, and (3) the success of local shop supervisors in "selling" their managements to the urgent necessity of installing modern equipment and methods. This must be done if maintenance costs are to be reduced and equipment maintained at the high standard essential for safe and satisfactory operation at the ever-increasing speeds demanded by the modern shipping and traveling public.

Still another factor in the problem, which must not be overlooked, is the provision for as uniform shop operation as possible, considering the variable character of railway traffic and equipment requirements. When the Chicago Great Western, for example, revamped its shop facilities at Oelwein, Iowa, to the extent of purchasing all new machinery in place of equipment averaging over 30 years old, as described in the June, 1935, *Railway Mechanical Engineer*, its officers did not let the matter rest there and say, "We have installed new machinery at a cost of approximately $100,000. Now we can cut our costs." They took the necessary steps to provide the uniform operation without which potential savings in unit shop costs can never be realized.

Previous to 1934, the method of shop operation at Oelwein was more or less spasmodic. Program work was sometimes completed as contemplated, but frequently dropped for a period of two or three weeks when carloadings fell off. When the shop re-opened a loss in output of as much as three days' work usually resulted due to delays in locating misplaced tools, hunting for material robbed from the shop for use on light repair equipment, and getting the shop organization really to function again. To prevent a recurrence of these costly delays, the purchase of new machinery and equipment at Oelwein shops was coupled with a reorganization of the entire method of shop procedure. Budgets are now prepared 30 days in advance for maintenance work on locomotives and other equipment which have been given a thorough inspection, and necessary repair materials ordered so that they will be on hand before the equipment is shopped. Each locomotive is scheduled from week to week and every foreman furnished with a copy of the schedule. The stores department also receives a copy and is required to see that all necessary material is available at the shop prior to the scheduled date.

This co-ordination of modern facilities and shop practice has resulted not only in lower costs but has provided a more consistent output with steady employment for the employees. It has also permitted the railroad to do additional maintenance work on equipment with the savings which have resulted from the installation of new machinery. Since July 9, 1934, the shop has worked steadily without layoff periods, except during the seasonal holidays. Other important savings, somewhat difficult to evaluate, result from more accurate work and closer tolerances possible with modern machines, increased service life with surface-hardened materials finished on grinders, and generally improved morale of shop men working with modern tools. It is estimated that the Chicago Great Western has already saved in the last two years its entire investment in improved machines and shop equipment.

This saving, as a result of replacing obsolete equipment, would not have been so great had the equipment been only 10 years or so old and still fairly modern, but, as a matter of fact, the machines were over 30 years old on the average. The resultant low production of relatively inaccurate work can be more readily imagined than described. It took from 15 to 40 minutes to turn a motion-work pin on a 30-year old turret lathe, whereas this operation can be performed in a few minutes on a modern lathe. Many other operations were being performed on similarly inefficient worn-out machine tools. Drills, reamers, milling cutters, taps, dies, etc., would not "stand up" when cutting modern steels, and rapidly wore out or broke. Obsolete pneumatic tools also were wasteful of air, not to mention shopmen's time, and seriously retarded production. A comparison of the time required to perform several typical locomotive shop operations with the old equipment and with new modern facilities is shown in the table.

An indication of the improved quality of work per-

formed at Oelwein shops since the installation of new machinery is afforded by the substantial increase in the number of locomotive miles run per engine failure, this mileage being 53,256 in 1932; 68,873 in 1933; 78,455 in 1934; and 121,208 in 1935. Not all of the credit

Comparison of the Time Required for Several Typical Operations with New Versus Old Shop Equipment

	Old	New
Unwheeling a 2-8-2 Class locomotive....	10.5 man-hours	1.7 man-hours
Wheeling a 2-8-2 Class locomotive......	26.7 man-hours	5.4 man-hours
Turning one pair of 56-in. driving tires.	3.0 man-hours	.9 man-hours
Pressing wheel centers off and on.....	.5 man-hours	.17 man-hours
Grinding valve links..................	7.0 man-hours	.75 man-hours
Removing flexible caps, 2-10-4 locomotives	42.0 man-hours	5.0 man-hours
Applying flexible caps, 2-10-4 locomotives	52.0 man-hours	6.5 man-hours

for this improvement can, of course, be given to new machinery, since numerous other factors have an important bearing on failures and maintenance costs.

Some railroads have been prone to defer the modernization of their shop facilities due to the heavy charges to operating expenses which are involved, irrespective of the amount of savings that the new equipment will bring. If the purchase of new equipment will result in a saving of 20 per cent or more on the investment, some roads feel that the installation is justified. In a great many instances of individual machine tools, however, savings substantially greater than 20 per cent may be anticipated. The new equipment purchased would not necessarily have to mean an immediate cash outlay, as arrangements could be made with machinery manufacturers for payments spread over a reasonable period of time.

Apprentices—An Imperative Need

Improved business conditions during recent months, even though production is well below what might be considered normal, has focused attention on one of the weak spots in our present-day set-up. Recruiting and training of employees has been at an exceedingly low ebb in recent years; indeed, it has been practically discontinued in many industries. Meanwhile many of the older men have died or have retired; others, in the prime of life, have been laid off and have related themselves to other occupations. Many of this latter class will never resume their former occupations. American industry, therefore, is facing a serious situation, if and when business swings back into a more normal stride.

Apprentice Training News, a bulletin issued by the Federal Committee on Apprentice Training at Washington, in commenting upon the revival of apprentice training on the railroads, makes this suggestion: "The idea of restoring training, with the related instruction, under public school supervision has met with general approval. Several roads have decided to put on apprentices immediately. In Colorado an agreement has been made whereby the railroads and vocational schools will co-operate in providing a traveling instructor."

The railroads during the first quarter of the present century took the leadership in introducing modern apprentice training methods. This included the introduction of apprentice shop instructors, as well as classroom instruction. Naturally, also, as higher standards were introduced, more and more attention was given to the proper selection of the apprentices. Largely because of these methods—on those railroads which were progressive enough to adopt them—a goodly supply of capable mechanics was provided, some of the more outstanding of these well-trained journeymen eventually qualifying for positions as foremen and supervisors.

The shutting off of the influx of young mechanics into our railroad shops in recent years promises to have serious effects, unless determined measures are taken immediately to resume recruiting, at the same time making unusual efforts to see that the very best sort of instruction is given to the apprentices.

Are You Living Off Your Family?

Some years ago at a railroad meeting, which was attended by men from several departments, a rather heated discussion developed which gradually resolved itself into a game of "buck-passing," representatives of one department inferring, at least, that certain conditions might be corrected if the representatives of another department would do what they should. There was present a railroad man with years of experience who, tiring of much pointless argument, got up and eased the tension somewhat by prefacing his remarks with the statement that it was quite obvious that many of those in attendance at that meeting were "members of the same family but apparently not closely related." The readers of this publication have been entertained and we venture to say constructively educated during the past months by the writings of Walt Wyre, and one gains the impression upon reading this month's contribution entitled "Robbing Peter," which appears on page 264 that the mechanical and maintenance departments may be members of the same family but not very closely related. The ultimate solution to Foreman Evans' perplexing problem was one which, unfortunately, is too often the only one available to hard-pressed foremen.

The broad problem of maintenance of equipment is one which involves properly designed equipment, adequate repair facilities and intelligent management. Walt Wyre has portrayed in his inimitable manner another of Jim Evan's dilemmas out of which he usually finds a way. In this particular one, we venture to suggest that management is somewhat at fault for Master Mechanic Carter turned his back on a situation about which something should be done. It is to be hoped that no mechanical department man in a position of responsibility will read this month's story by

Walt Wyre without realizing that every time a situation arises wherein the efficient service of a railroad is handicapped by the existence of obsolete facilities somebody pays the bill. A railroad may have fine tracks, modern locomotives and cars, a willing and efficient personnel but if its shop and enginehouse facilities are not able to meet the standards of performance which modern equipment is able to give, the profits that are realized by the modern facilities in one department may be to a large extent offset by the losses in another. Under the conditions with which railroads have had to contend for the past few years, there has grown up a tendency to look out for oneself and too often that pride of departmental accomplishment in keeping within the budget has been carried out at someone else's expense.

There are so many evidences of the value of modern machine tools and shop equipment that it is not so much a problem of determining whether a road can afford new facilities as it is one of determining how long it can afford to continue to pay the losses of inadequate facilities. When one considers that the average railroad does not expect shop facilities to pay for themselves in less than five to ten years and that most modern units if used to capacity will pay for themselves in considerably less than that, it will be surprising if the hesitancy in modernizing repair facilities that has existed for the past several years is much longer continued.

Firemen on Diesel Motive Power

Announcement was made near the end of May that the New England roads have settled the issue which had threatened to result in a strike of the members of the Brotherhood of Locomotive Firemen & Enginemen by agreeing to use firemen as helpers in the cabs of present Diesel locomotives and motor cars. This agreement follows an aggressive campaign which was waged by the Brotherhood on the ground of safety, which is also the ground on which efforts have been made to secure legislation requiring two men in the cabs of Diesel-driven rolling stock in some of the other states.

One can understand the desire of the Brotherhood officers to secure as many jobs as possible for its members and at the same time to endeavor to check a trend caused by any increase in the general utilization of Diesel motive power which otherwise would materially curtail the opportunities for employment of the men which this Brotherhood represents. As a safety measure, however, the requirement that enginemen in the cabs of Diesel-driven cars and locomotives be accompanied by helpers is of extremely doubtful value. There are many instances of the ineffectiveness of the fireman in the cab of the steam locomotive as a check on the engineman in cases of mental lapse or collapse. Furthermore, where these men are employed on electric locomotives with no duties of their own to occupy their attention, the evidence indicates that they are no more dependable as checks upon the condition and responsibility of the engineman than are the firemen occupied with their own duties on steam power. Indeed, the evidence strongly suggests that the lack of distinctive duties of their own makes them undependable as watchers over the enginemen.

On the Spokane, Portland and Seattle on December 17 of last year occurred a freight wreck within yard limits under conditions which strongly indicate a mental lapse on the part of the engineman which was discovered too late by the fireman and head brakeman, both of whom were in the cab, to permit any effective action to prevent the accident. On January 30 a Reading passenger train was wrecked due to excessive speed on a sharp curve. The evidence strongly suggests the collapse, or the mental lapse, of the engineman a short time before the curve was reached. Emergency application of the brakes, which the position of the engineer's brake valve after the accident would indicate had been made, was too late to be effective. On last September 27 a rear-end freight collision occurred on the New York, New Haven & Hartford in electrified territory. Just before the collision the helper walked back from the front-end of the locomotive to overcome drowsiness and was not present to be of any service in preventing the failure of the engineman properly to observe and obey a restrictive signal indication.

There are two types of conditions against which safeguards are needed. They are (1) the collapse, or (2) the mental lapse of the engineman. It seems probable that the "dead man" type of control is the best protection against the former. Just what protection can be developed against the latter, in which the absence of complete physical collapse may prevent the "dead man" feature from functioning, unless it be assurance of proper health and proper rest on the part of the engineman, it is difficult to visualize. Many instances suggest the inadequacy and unreliability of a second man in the cab as a means of preventing accidents in such emergencies. Indeed, the absence of duties to keep him alert and, to some extent, of an adequate sense of responsibility on the part of the second man in the cab of electric or Diesel-electric equipment, whose only reason for being there is to draw his pay, creates a menace by tending unjustifiably to divide the sense of responsibility on the part of the engineman. It is a serious question whether safety would not actually be promoted if these men were paid for their trips but not permitted to set foot inside the cabs.

One can understand the desire of these men for jobs, but it is difficult to believe in the sincerity of the argument that their jobs promote the safety of railway transportation.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Is Walt Wyre Color Blind?

You might ask Mr. Wyre if he is certain that Interstate Commerce Commission Form 5's are blue. The ones I have seen were rather pink. I will admit, though, that the effect produced by such an apparition is decidedly blue, if any color sense at all is present at such a time.

From Far Off China

Although the practices adopted by us are somewhat different from yours, we are always looking forward for improvement and ready to take advice and suggestions. It was last year when we were confronted with the problems of broken axles and hot boxes. In the second case, we found references in your January, 1934, issue. You had the same trouble and you also tried to remedy it by adopting one grade of journal lubricant after a series of service tests.

"East of Suez"

Our problems are many in a country like India, where labor is extremely poor and not mechanically minded, and European supervision scarce, whilst the design of rolling stock, particularly for our 5-ft. 6-in. gage presents unusual difficulties, due to the large size of equipment for handling by Indian labor. The articles which are of great use are those dealing with workshop equipment and gadgets. If you could kindly give more particulars of this nature I am sure it will be welcomed by all mechanical railway men out "East of Suez."

New Age in Railroad Transportation

As he widens his knowledge he sees unfolding before his eyes the opening drama of a new age in railroad transportation. In the 30 years I have been in the railroad game, what a transformation has taken place and what have we today? In locomotives: Diesel-electric power, the application of the roller bearing, new type of air brake apparatus, streamlining, new steels, new welding processes, higher boiler pressures. In passenger cars: Air conditioning, the roller bearing, improved dynamo and battery equipments with better lighting, and wonderful improvements in interior appointments.

No Reserve of Trained Mechanics

I do not know of anything of a more serious nature confronting the mechanical departments of the railroads, should they suddenly be offered a large volume of traffic, than the shortage of trained mechanics. When the falling off in traffic occurred five or six years ago and the railroads found it necessary to reduce their shop forces, the younger men were laid off, leaving many of the shops with only a skeleton force of men, all of whom were practically past middle age, as only those who were old in the service had senior standing sufficient to hold a job. Many of these have since dropped out through death and other causes and in many cases their places have not been filled. Due to the length of the depression, the young men who were laid off, when the reduction in forces was first made, have sought employment elsewhere, until now there is no reserve of trained mechanics for building up forces or from which to choose supervisors.

Firing Men

A man recently applied to me for employment. Here is the conversation:

"What is your specialty?"

"I am a maintenance man. I can set up machinery and countershafting and can repair any machine that may need it. I am also fairly good at giving an estimate of how long it will take to get the machine in operation."

"Where did you work last?" I asked.

"I have been working for the ——— Company for four years."

"Why did you leave?"

"Well, to be honest, I was fired."

"What for?"

"I really don't know. They don't tell you over there; you just get an envelope on your way out at noon or night with your pay in it and a note that your services are no longer required; and no one will tell you why.

"Have you no idea at all?" I inquired.

"No, I haven't. I never lost time. I have broken no rules knowingly and have never been bawled out at any time. I did break a small tap on my last job, but I do not think they would fire a man for that. On the other hand, the new foreman over there is just out of college and perhaps doesn't know how easily a tap may be broken, especially when used in awkward locations on repair work. I don't suppose he ever used a tap himself."

"Sorry I have no opening for you," I said. "I am well acquainted with the people over there and am surprised at what you say."

A little later I had the opportunity of meeting the works manager of the plant, with whom I was well acquainted. The following conversation took place.

"Is it true," I asked, "that when you people let an employee out, you don't tell him the reason?"

"Unless it is a reduction in staff," replied the works manager, "they are not given a reason for discharge. We just let them work until the end of the day, and no matter what the cause, it saves a lot of argument and sometimes unpleasant controversy. As they go out, we give them their check and their notice of dismissal in courteous language."

"Well," I said, "don't you think a man is entitled to know just wherein he fell short of requirements?"

"No, I don't think that is necessary at all. If he is so dumb that he doesn't know, then he is too dumb to have around; and if he knows, why is it necessary to tell him?"

"Do you, yourself, always make it a point," I asked, "to know why your men are discharged?"

"Oh, I can find out from the employment clerk if I wish to know. We have over 1,000 working for us and I can't be troubling myself over who gets let out. Do you know why every man gets discharged?"

"Yes, I do," I replied. "I always manage to find time to talk to the man. I like to get his version of it. I like to be sure someone else is not at fault. There are plenty of forms of punishment short of complete dismissal, which need not cost the management nearly as much as a payroll separation would. You know, any citizen could commit quite an offense and it would not cost him $25.

"Well, what do you gain by all your trouble?" asked the shop manager.

"I gain the satisfaction of protecting our company from charges of injustice to its men. Since adopting the practice of investigations, dismissals have practically entirely disappeared and we have the most efficient shop organization in the city, as you yourself have so frequently stated."

With the Car Foremen and Inspectors

Interior of the reconstructed Port Huron freight car shop while a box-car rebuilding program is being carried on

Port Huron Car Shops

Following a fire which occurred over a year ago and destroyed the north half of the Grand Trunk Western freight car shops at Port Huron, Mich., the shop was rebuilt, enlarged and equipped for the expeditious handling of the heavy freight-car repair and rebuilding programs which it was foreseen would have to be carried out during 1935 and 1936. A total of 240 welded steel hopper cars and 150 steel box cars were rebuilt at Port Huron shops in 1935, and material has been purchased for 350 additional box cars and 600 hopper cars authorized to be rebuilt during 1936. With the improved shop thoroughly organized and employing about 600 men, 40 hours a week, the production is three hopper cars or three box cars a day. This is in addition to light repair work which is carried on outside of the shop, and a considerable volume of work on special equipment cars such as those used for the shipment of automotive gas engines, axle assemblies and other special materials.

The Grand Trunk Western freight-car shop at Port Huron, Mich., consisted of a building 360 ft. long by 160 ft. wide, with brick walls and wooden roof trusses supported on the walls and on posts spaced 20 ft. center to center in each direction. An interior brick wall on the longitudinal center line divided the building into two aisles. The building was floored with concrete, and four tracks extended through each aisle in a longitudinal direction. On January 9, 1935, a fire destroyed all of the north half or aisle of this building, but the brick firewall prevented the fire from getting into the south aisle to which no damage was done, and it was placed back in service in 24 hours, or as soon as service pipes, electric conduits, etc., that passed through the part that was destroyed, could be restored. The fire also destroyed a low wing along a part of the north side of the building that was used for various incidental operations.

The destroyed part of the building was restored by making use of a part of an old station building known as the Whipple car shop at Elsdon yard, Fifty-first street and Central Park avenue, Chicago. Structures at this point included two buildings 80 ft. wide by 500 ft. long, consisting of structural-steel frames with trusses spanning the full 80 ft. and covered on the outside with corrugated metal that subsequently proved to be genuine wrought iron. One of these buildings, equipped with a 7½-ton traveling crane, was dismantled and re-erected at the site of the destroyed half of the building at Port Huron, the additional length being extended beyond the west end of the original building, as shown in the drawing. The building used had a lean-to on one side 160 ft. long by 30 ft. wide. This was also re-erected on the north side of the building at Port Huron, but the span length was reduced to 28 ft. in order to clear an existing track. It was necessary to provide new concrete foundations for the steel columns, but the old floor was retained in service, a cinder floor being provided in the extension to the west as well as in the lean-to on the north. It

was necessary to make some alterations in the old steel work for the purpose of introducing reinforcements to take care of corroded portions as well as to remodel the two ends of the building to provide doors that would fit the location of the existing tracks.

The old wrought iron is used in the reconstructed building but in a different manner than before, owing to the desire to provide a type of wall which will be more effectively insulated. For this purpose, a three-ply wall is provided, consisting on the outside of corrugated metal, a layer of ½-in. fiber insulating board, waterproofed, and then the old wrought-iron sheets on the inside. The building is provided with mechanically operated Truscon steel sash, is heated by means of a series of 15-unit heaters using steam at 100 lb. pressure from the shop power plant in copper coil radiators and provided with electric fans. The building is provided with electric-welding circuits, oxygen and acetylene service pipes, outlets for extension lighting cords and for power take-offs, and general lighting is afforded by beehive-type glass reflector fixtures suspended from the roof purlins. Spotlights are used as supplementary sources of light. The lean-to on the north is heated by direct radiation.

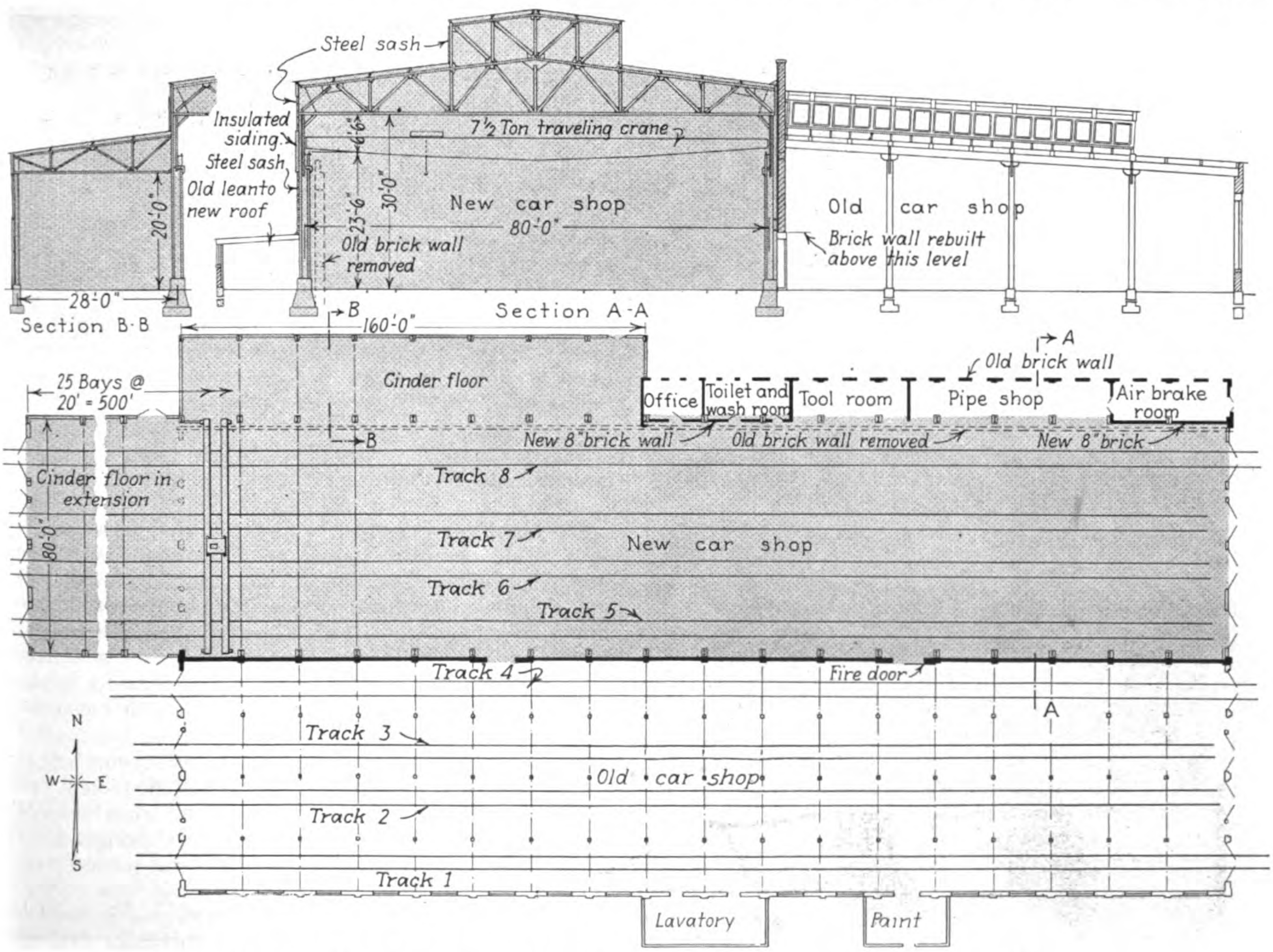
The old steel work that was used was taken down by company forces and prepared for used by company forces and also by the Duffin Iron Company of Chicago. The new building was erected and all work done under contract by the Austin Company, Cleveland, Ohio. The 7½-ton traveling crane was reused exactly as in the original installation with the exception that the motors had to be rewired and all of the bearings rebabbitted.

How the Car Rebuilding Operations are Carried On

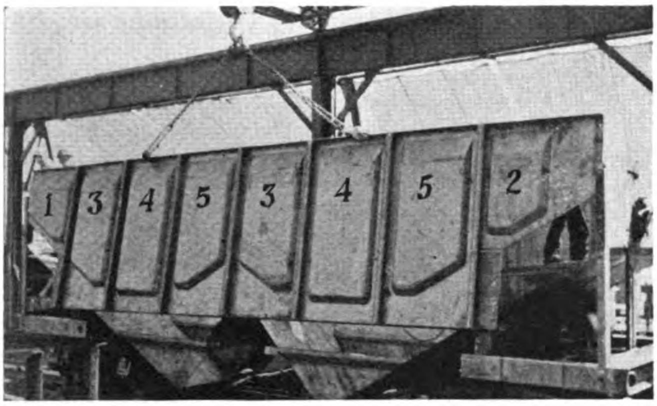
The 50-ton steel hopper cars, rebuilt at Port Huron shops, were of conventional riveted design, equipped with arch-bar trucks, Type K air brakes. Their light weight was 38,100 lb., nominal capacity, 130,000 lb., cubic capacity, 1,680 cu. ft. and load limit, 130,900 lb. In the rebuilt cars, the use of pressed-steel side panels permitted increasing the cubic capacity to 1,735 cu. ft. with the same inside length, width and height. The extensive use of electric welding, not only in assembling the side panels but in fabricating the entire car, also permitted reducing the light weight to 37,300 lb., or, a decrease of about 800 lb. which is available for additional load-carrying capacity.

Relatively few parts of the car frame and superstructure were salvaged in this rebuilding operation, the good usable material incorporated in the new hopper being valued at only about $300. Aside from the new steel side panels, sheets and structural shapes, other new material applied to the cars includes Type AB brakes and new hand-brake operating mechanisms, cast-steel truck side frames, hopper doors and fastenings and an average of about two pairs of wheels and one new draft gear per car.

The sequence of work in rebuilding these steel hopper cars may be more readily followed by referring to the drawing which shows the new car shop and track layout. Tracks 1 to 4, inclusive, are in the south aisle of the old shop and Tracks 5 to 8, inclusive, in the north aisle, or new shop, the latter being equipped with the 7½-ton



Plan and sections of the Port Huron car shop—Reconstructed portions are indicated by the shaded areas



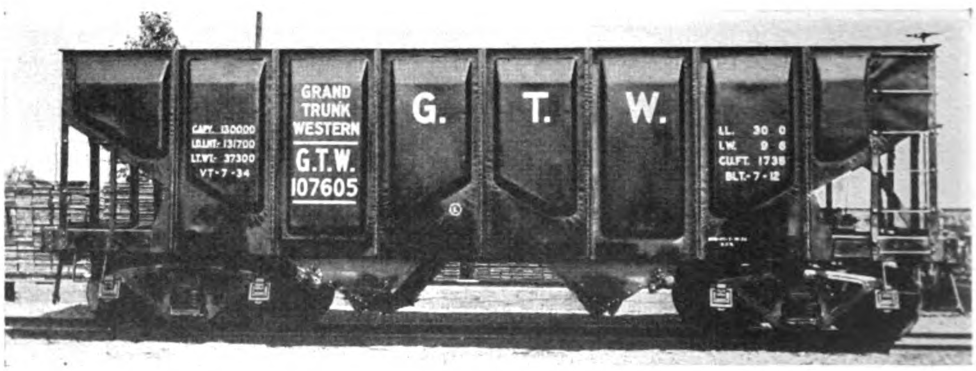
Welded steel car side comprising eight panels of only five different shapes

overhead crane. The location of the various shop departments is clearly shown in the drawing. Tracks 4 and 5 are connected by a switch at the east end of the shop so that cars worked through the shop on one of these tracks can be switched to the other and worked back through the shop in the reverse direction. The same method of operation can be used with Tracks 7 and 8 which are also connected by a switch east of the shop building. Car movements within the shop are made almost exclusively by means of an electrically operated car puller.

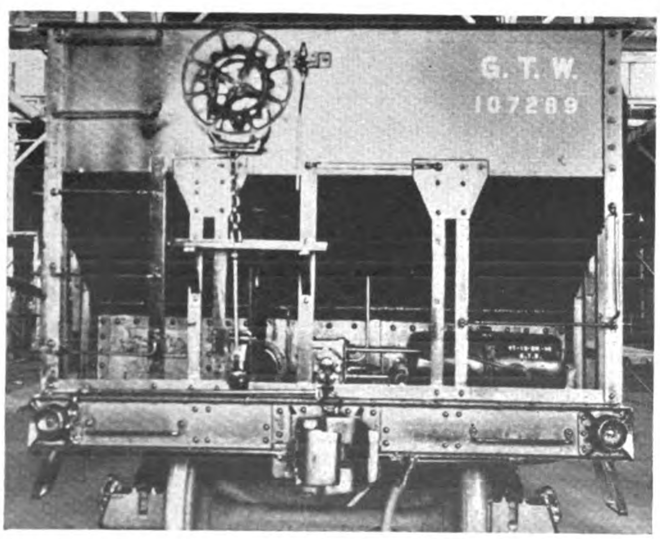
Steel hopper-car rebuilding work is divided into 10 major operations, as shown in the following schedule:

Operation 1—Old steel cars are cut down, largely by use of the gas cutting torch, on Track 5 about 200 ft. west of the shop, all usable parts, such as wheels, axles, truck bolsters, brake beams, body bolsters, etc., being

Grand Trunk Western 50-ton hopper car before being rebuilt



View of the 50-ton hopper car after reconstruction



The air brake and hand-brake applications to one of the 50-ton cars

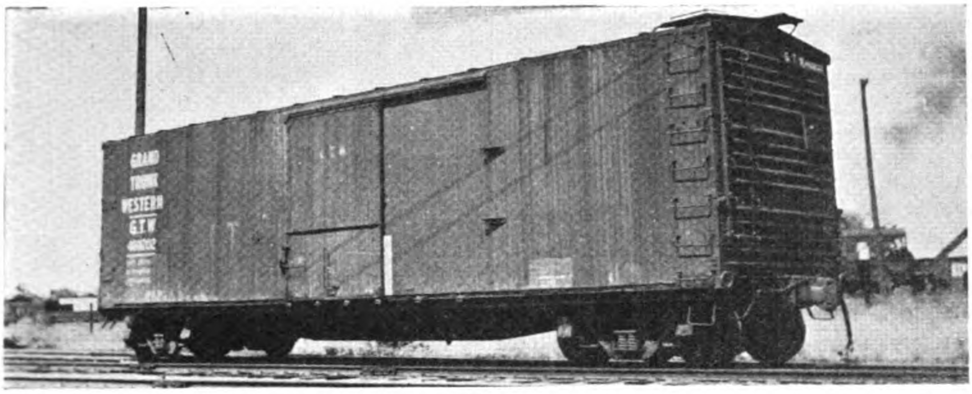
salvaged. Scrap is loaded here by the locomotive crane for shipment to Battle Creek where major reclamation operations are carried on.

Operation 2—Salvaged parts are moved into the shop on Track 5 on material flat cars, new center sills being assembled at this position.

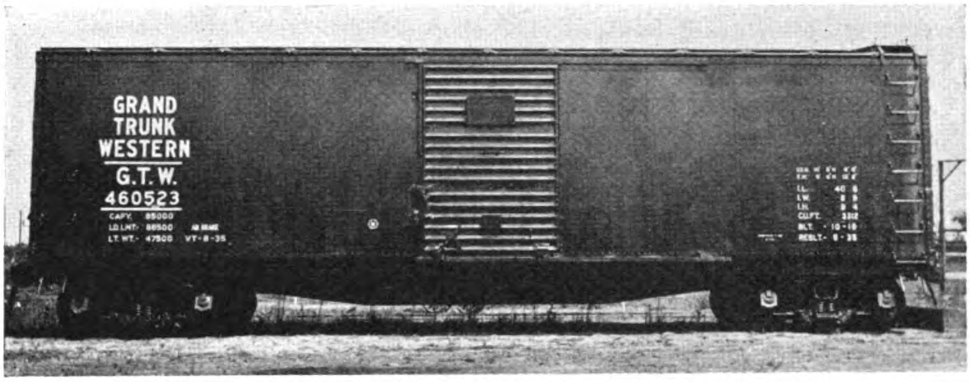
Operation 3—Advancing to the next position on Track 5, the bolsters, end sills, AB brake equipment, cross hoods, end sheets, longitudinal hoods and inside hopper sheets are welded in place. No-Ox-Id, applied with a brush, is used wherever necessary at metal contact points to prevent corrosion.

Operation 4—At the extreme east position on Track 5 in the new shop, the trucks are assembled, new cast-steel truck slides being applied. These truck assembly operations are facilitated by use of a pneumatic jib crane, the complete trucks being lifted and moved across to Track 6 with the overhead crane.

Operation 5—The assembled underframe is lifted by means of the overhead crane and set on trucks on Track 6 in the east end of the shop. Here the slope sheets,



Grand Trunk Western 40-ton box car before being rebuilt



The 40-ton steel box car after reconstruction

outside hopper sheets and complete welded panel sides are applied by welding.

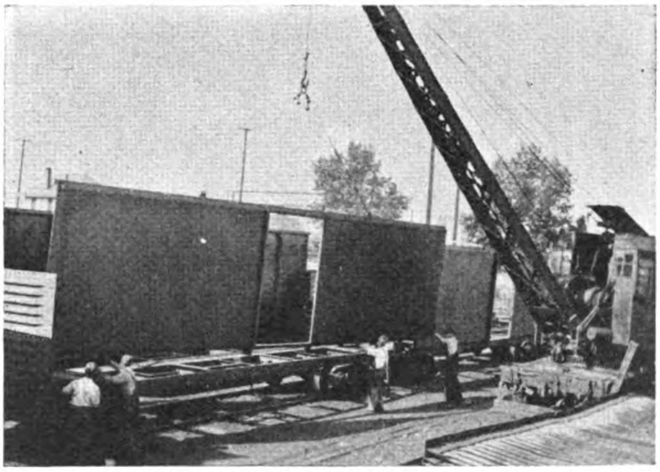
Operation 6—The car is moved westward on Track 6 and safety appliances fitted in place at the next position.

Operation 7—Floor sheets and side panels are welded together and necessary rivets driven in safety appliances and other parts of the car.

Operation 8—At this position on Track 6, the hopper doors are applied and all pipe fitting work completed.

Operation 9—The cars move out of the shop and are switched to the sand-blast shed (described on page 66 of the February *Railway Mechanical Engineer*) where all sheets are thoroughly cleaned and the priming coat and finishing coat are sprayed on.

Operation 10—The cars are then switched to the north end of the passenger car shop where stenciling is applied by the spray method (see page 67 of the February *Railway Mechanical Engineer*) and a final inspection made, the cars finally being switched to the scales where they are reweighed and released for service.



Application of one of the steel car sides by the use of a locomotive crane

Side-Panel Welding Details

The pressed-steel panel sides, applied in Operation 5, are previously assembled and welded complete on movable jigs in the machine shop, located just west of the main freight-car shop building. Referring to the illustration with numbered panels, it will be seen that each car side consists of eight separate pressed panels, but only five different sizes and shapes. In other words, the number of different panels has been minimized and each car side consists of a No. 1 and a No. 2 panel, two No. 3 panels, two No. 4 panels and two No. 5 panels.

These eight panels are assembled in the jig, special edge-type clamps being applied to hold the panel edges in alignment. The top side-angle seam is first skip welded at 2-in. intervals, using ¼-in. coated-wire electrodes. The seams between panels are completely welded and the top-angle seam weld finished. The car side is turned over in the jig and the panel seams welded downward. The bottom edge of the top angle is then welded to the panels starting from the center and working towards each end to avoid buckling. Any little curvature of the top angle is taken care of in assembly by side-sheet gussets and crosstie beams.

All of this side-panel welding is performed at the rate of 20 ft. an hour or 160 ft. a day. Two welders work simultaneously while each side is being welded. The total amount of welding in fabricating the entire car structure comprises about 995 ft. of welding per car. When the hopper-car rebuilding work is in full swing, welding operations are carried on by two shifts. The shop is equipped with fourteen 300-amp., single-current electric welding machines.

Operations in Rebuilding Box Cars

The 40-ton steel underframe, wood superstructure box cars referred to are rebuilt into modern double steel-

sheathed box cars having a light weight of 47,500 lb., nominal capacity of 85,000 lb. and load limit of 88,500 lb. By the application of steel sides of the Youngstown type, it has been possible to increase the inside car width from 8 ft. 6 in. to 8 ft. 9 in. The car height is also increased from 9 ft. to 9 ft. 4 in. by the application of a filler strip in the two-piece ends. Dry-Lading car roofs and Youngstown steel doors are applied, as are also AB brakes, new hand-brake operating mechanisms and cast steel truck sides. As in the case of the hopper cars, other new equipment includes, on an average, two pairs of wheels and one new draft gear per car.

The only welding in conection with the box cars is a 15-ft. strip in the door-track angle to avoid leaks. All unnecessary holes are plugged, and welding is applied at the corner junctions of the end and side sheets to prevent the possibility of leakage. The shop is fully equipped with modern tools and machinery needed for the expeditious handling of box car work. Floors are

Pneumatic nail-driving machine used in spiking the car floor

spiked with air-nailing machines which drive 3-in to 6-in. spikes. Four pneumatic saws, with 8-in. blades and 2½-in. maximum depth of cut, are used. Nuts are tightened by power nut-tightening devices, while portable cranes handle material directly to the job from the storage pile.

Operations in rebuilding the 40-ton steel box cars are performed in 11 progressive steps, as follows:

Operation 1—The old box cars are dismantled in a track area of about 2,000 ft. west of the shop, where adequate space is available for the removal and burning of all old wood.

Operation 2—Cars are moved to shop Tracks 2 and 3 inside the shop, where they are jacked up on horses and the underframes, steel corrugated ends, trucks, draft gears and AB brake equipment applied.

Operation 3—Each car is then moved just outside of the freight shop building at the west end where fabricated complete steel sides are applied with a locomotive crane.

Operation 4—The car is switched to Track 7 and placed in the shop where corrugated ends are fitted to the sides and steel doors applied in the first position. The entire roof assembly of ridge pole, carlines and purlins is placed in position by use of the overhead crane, these assemblies having been fabricated in advance.

Operation 5—The car advances to the next position on Track 7 where all rivet driving is done and safety appliances put in place.

Operation 6—The car is moved over the cross-over switch at the east end of the shop to Track 8 where wood nailing sills are applied at the first position on the return movement.

Operation 7—The car then advances along Track 8 to the next position where decking is applied and the floors spiked, using the automatic nailing machine, shown in one of the illustrations. Odorless cement is applied with a hand gun around the sides and ends of the cars to seal the decks.

Operation 8—Side nailing posts, wood end fillers, grain slides, door posts, threshold plates and deck transom plates are applied.

Operation 9—At this position the side and end lining are applied.

Operation 10—Complete metal roofs and runboards are applied, No-Ox-Id being used at metal contact points to prevent corrosion. Air brakes are tested.

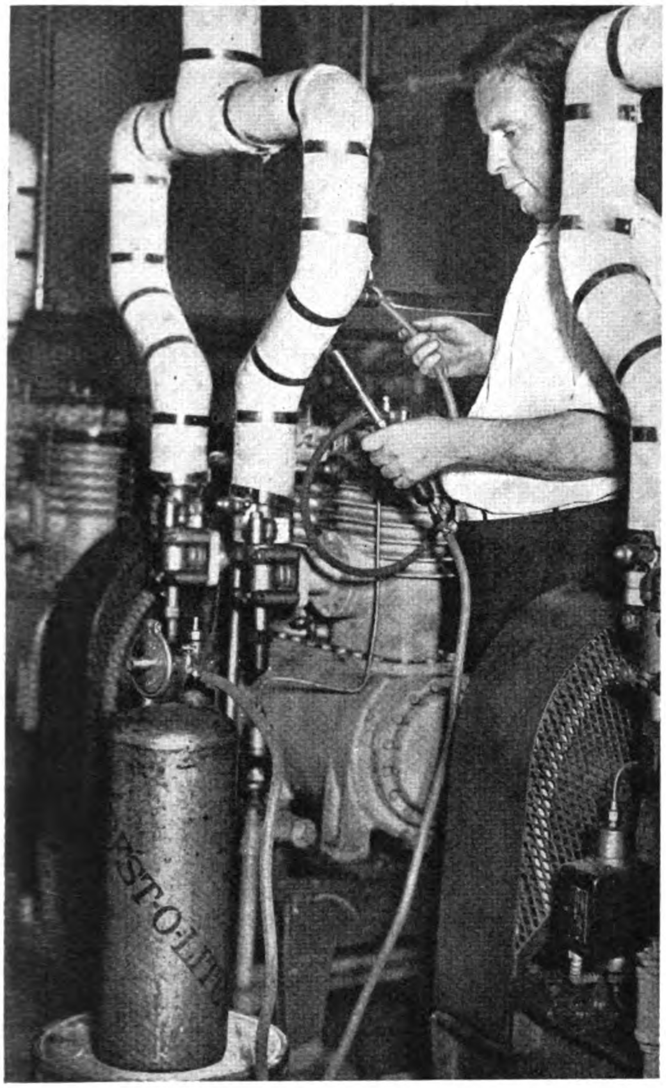
Operation 11—The car then leaves the shops on Track 8 ready for painting and stenciling which is done outside on tracks south of the shop building. The final inspection is made here, the cars being reweighed and released for service.

Halide Leak Detector For Refrigerant Gases

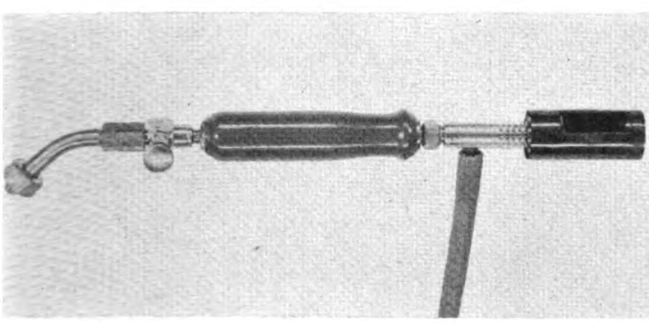
In a majority of the large number of air conditioning systems now installed in railway passenger cars, Freon is used as the refrigerating agent. This gas is relatively odorless, tasteless, and colorless. Leaks in the system are, therefore, difficult to detect until much valuable gas has been lost or until the system fails to operate. In order to insure effective operation and to eliminate the expense of leakage losses it is necessary that there be provided a quick and sure method of locating gas leaks in these cooling units, either at the time of installation or when in service. With a view to meeting this need, the Oxweld Railroad Service Company, 230 North Michigan avenue, Chicago, has recently perfected and placed on the market the Prest-O-Lite Halide leak detector which consists essentially of a handle with a needle valve and a burner which includes a suction nipple for attaching a rubber hose. A chimney with a copper reaction plate fits on top of the burner. The detector is furnished ready for mounting directly on a Prest-O-Lite MC gas tank. It can also be used with the B or E tank.

The detector flame is adjusted so that the top of the cone is level with or slightly above the chimney. The flame when so adjusted heats the copper reaction plate and the detector is then ready for locating leaks.

The suction tube is used to explore around places



Testing refrigerant pipe lines for leakage of freon



Halide leak detector for locating leaks in non-combustible refrigerant gas lines

where leaks might occur. The rapid flow of acetylene through the burner causes refrigerant gas near the open end of the suction tube to be drawn into the burner where it decomposes into free acids. These acids, coming in contact with the hot copper reaction plate, cause instant color change in the flame. A green tint indicates a small concentration of gas. When a large amount of gas is present, the flame assumes an intense violet color.

If the leak is sufficient to give considerable refrigerant gases to the atmosphere, the flame will burn with the characteristic green or violet color and might not show the exact source of the leak. In this case, the leak can be located by the variation in intensity of the color of the flame. After the source of the leak has been passed, the flame clears almost instantly. This sensitive reaction of the detector saves time in locating leaks, avoids waste of refrigerant gas and costly shutdowns of equipment.

It should be understood that a flame leak detector, such as the one described, should be used only when the refrigerant is a non-combustible gas, and it is, therefore, essential that the nature of the refrigerant gas be known before this device is used.

Fluid Strainer For Spray Guns

The DeVilbiss Company has developed a new fluid strainer, Type VS, for attachment to the fluid inlet of the Type MBC spray gun. The advantage of having the fluid strainer at the inlet of the gun rather than at the paint-tank outlet lies in the fact that a slight residue of material in the line or other dirt may be carried to the spray gun if the paint is not strained at the last point before entering the gun. This may cause defects in the finished surface.

De Vilbiss Type VS strainer for Type MCB spray gun

The working part of the strainer consists of a screen reinforced with coiled spring and inclosed in a metal tube. Fluid flow is from the outside to the inside of the screen which is easily removable from the tube for cleaning.

The Type VS strainer is connected by means of its upper or outlet connection to the fluid inlet connection of the spray gun, the fluid hose being connected to the lower or inlet end which is fastened to the lower end of the gun handle to prevent undue strain on the upper connection. The strainer design permits the fluid hose to be attached near the air hose, and to run parallel with it, making the gun easy to handle.

IN THE BACK SHOP AND ENGINEHOUSE

Fabricating All-Welded Gas Engine Cylinder Heads

The West Burlington (Iowa) shops of the Chicago, Burlington & Quincy claim the distinction of designing and building the first welded all-steel cylinder head for a gasoline engine. This head was designed for the six-cylinder, 275-hp. Model-120 Winton engine used in most of the Burlington's gas-electric rail cars. The experimental head was completed in January, 1932, and is still in operation. Since that time, 168 of the Model-120 heads have been built as well as 55 heads for the Winton Model-148 engines which are used in some of the larger cars.

The Model-120 head consists of 61 separate parts and is fabricated entirely by electric welding. The majority of parts for this head consists of boiler steel for the flat plates and pressings and mild steel for the various pieces of round-bar stock that are used in the assembly. The time required for assembling and welding is approximately 40 hours a head. The fabricated head has nearly twice the water capacity and has 15 per cent less weight than the cast-iron head which it replaced. Worn valve seats are renewed by electric welding, and as no preheating is necessary, the time required for reconditioning per head is decreased appreciably. Statistics regarding the larger Model-148 head are approximately in the same proportion. A great saving has been realized in the actual cost of the steel head over that of the cast heads.

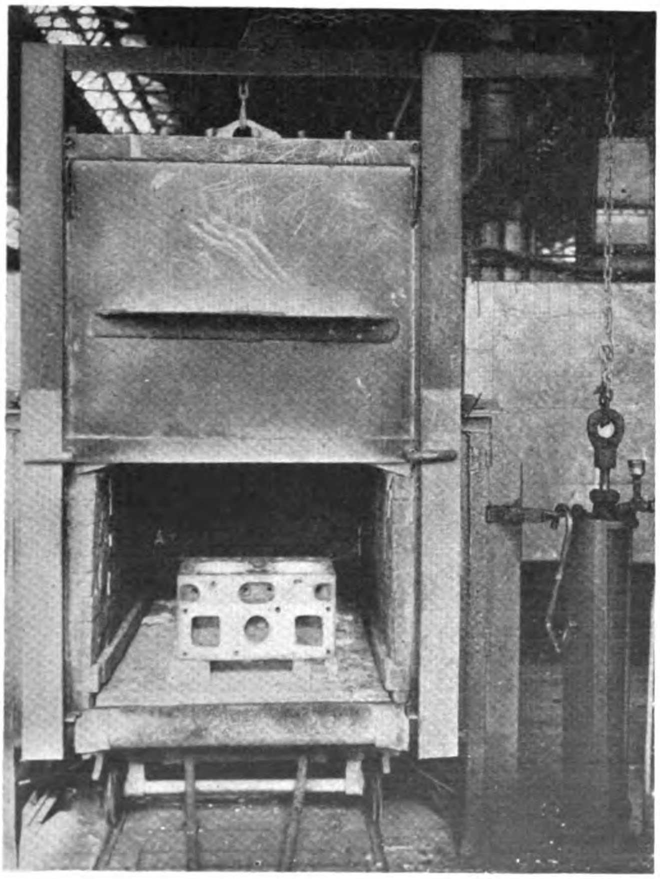


Fig. 1—Small car-bottom, oil-fired pre-heating furnace used in connection with cast-iron cylinder-head repair

In addition to the heads, cylinder blocks, upper and lower crank cases and intake manifolds have been constructed, all of steel and in a like manner.

The pre-heating furnace shown in Fig. 1 is an oil furnace using kerosene for fuel, size 31 in. by 53 in. by 28 in. inside, built from angle and sheet, having an oval top and a car bottom. It is lined with firebrick which is also used as the top surface of the car bottom. Track for the car is tee section, and extends 10 ft. outside of the furnace, where it is used while loading or unloading the car. Angle guides at the bottom of the furnace are hinged and counterbalanced so that when the car is in the furnace, the side and end joints are sealed. The furnace has an air-operated door, also lined with brick which is held in place by loose pipe, the brick being cut out on the edges to fit over the pipe. A supply tank is located outside of the building in the ground and piped to the furnace, the fuel being burned in shop-made burners. This furnace is principally used for repairs to the cast-iron cylinder heads which are still in service and require heating before and after welding operations are performed.

The pre-heating furnace shown in Fig. 2, size 48 in. by 72 in. by 21 in., uses charquets for fuel. The base of this furnace is designed with a ¾-in. top plate, perforated. The sides and ends are made from ¾-in. by 4-in. flat iron, on edge, with separators through the center making four compartments, and a ¼-in. plate on the bottom supported at each corner 6 in. from the floor by angle iron. Each compartment is piped for compressed air, having a clean-out. The sides and top are made from 1/16-in. sheet-iron, lined with asbestos mill board. These sides are supported at the center by tee iron which

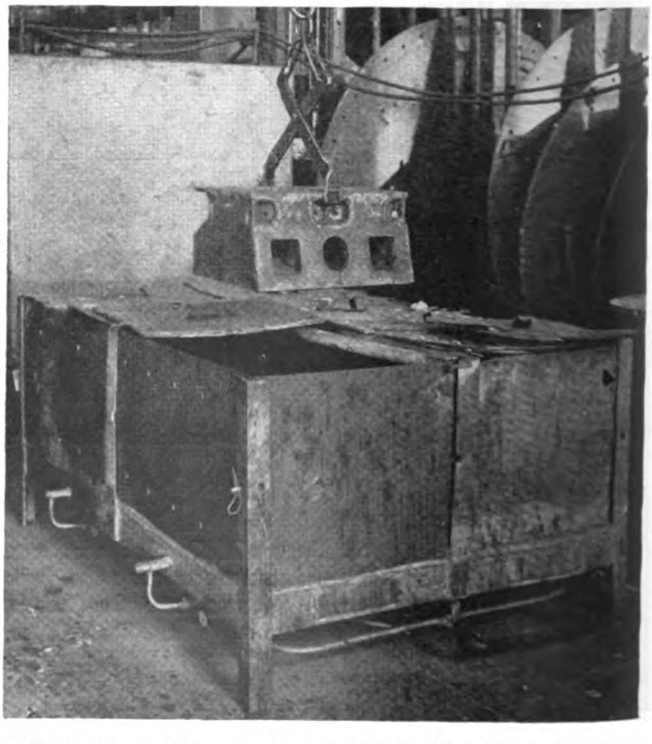


Fig. 2—Shop-made pre-heating furnace fired by burning charquets under forced draft, and divided into four compartments, one or all of which may be used, dependent upon the size of the part

also carries the bars that support the furnace top. In using this furnace, one or more compartments can be used, depending on the size of the parts to be pre-heated.

Shape Cutting Locomotive Parts

The utilization of flame cutting for the fabrication of heavy parts in locomotive manufacture is extensive and growing steadily as new problems are met and solved through its use. Two recent, similar interesting jobs involved some rather unique ideas with regard to the handling of the shape cutting machine itself.

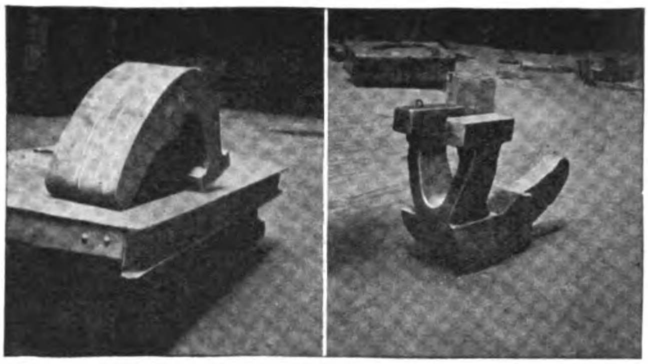
New designs of parts for the reverse lever mechanism for a certain type of locomotive required the solution of an interesting problem in shape cutting. These parts are known as "reverse lever arms" and "reverse lever crank arms." In each case the requirements for the shaping work were similar, and as a matter of fact the solution of one job, which was worked out first, gave the answer to the second. Essentially the problem was this:

The cutting operations had to be carried out in two planes. The first cuts were made on steel slabs 9 in. thick in the normal position, that is, with the slab lying flat on the material supports. The next cuts, however, were required to be made on the steel at right angles to the plane of the first cuts. When the material was first up-ended to make these next cuts, it was found that the cutting blow-pipe could not be raised sufficiently high. The machine was a standard one and ordinarily handles any but the infrequent, extreme job. The problem was overcome easily enough, however, merely by raising the cutting machine on some cribbing to the required height. It was then leveled off carefully and the work accomplished easily enough to set up the work on a production basis.

The first work was carried out on the part known as a "reverse lever arm." The rough sketches show the steps required for the formation of this part. Formerly this work had been done by a forging operation.

A steel slab 30 in. x 69 in. x 9 in. was procured for the raw material. The first of the three sketches shows the preliminary shape that was cut from the slab. This was a perfectly normal shape cutting job. The regular adjustments of the machine permitted easy handling of this, of course.

It was for the necessary second cuts in the plane at right angles to the first plane of cutting that required the raising of the cutting machine to a new level as described above. As it was necessary to set the steel up on its narrow edge to make these second cuts, it is obvious that considerable ingenuity was shown by the operator in reaching as simple solution to the problem as he did. It was, after all, a simple rearrangement of the machine, but one not generally thought about.

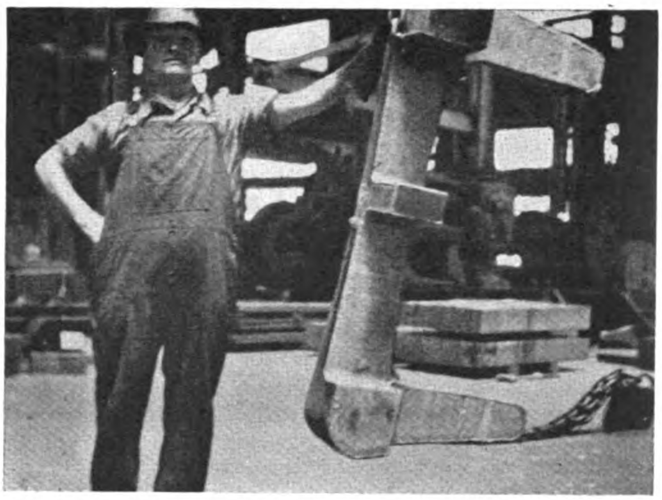


Left—After making the first cut for the reverse lever crank arm; Right—The completed part.

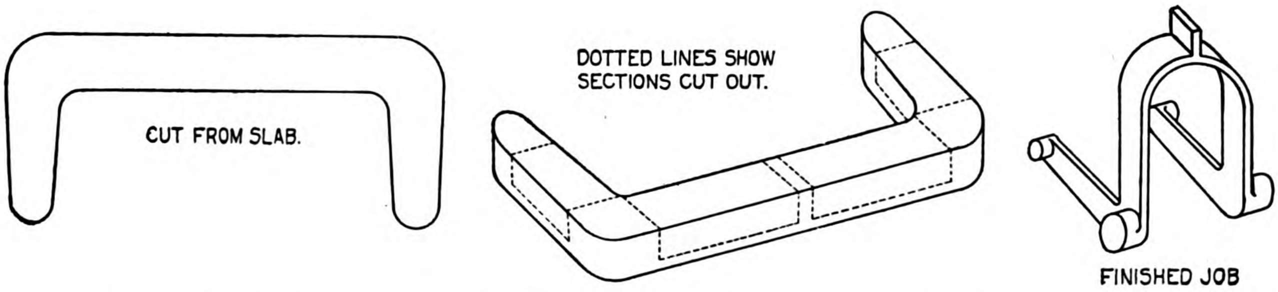
The third sketch illustrates the completed part after it had been finally bent and finish-machined to the final tolerances and to round out the pads and other parts. Incidentally, it is interesting to know that the heating for bending was done by the use of the oxy-acetylene flame.

The work on the "reverse lever crank arms," a similar part, was naturally enough patterned after that done on the "reverse lever arms." Some accompanying illustrations show these parts.

For these later fabricated parts the original steel slabs were 12 in. thick. The work was carried out in an exactly similar way as before. In connection with the preliminary preparation of the steel, it is worth noting that the entire surface of the steel was sand blasted before making any of the cuts. This precaution was made to eliminate any particles of oxide from flaking off and thus interfering with the smoothness of the cutting operation.



Three-dimensional shaping of this part eliminated an expensive forging job.



Three steps in the making of a reverse lever arm. Left—The first cut, made in 9-in. steel; Center—A rearrangement of the cutting machine simplified the second cuts; Right—The shaped steel was then heated with the blowpipe and bent to its final shape.

H. H. Carter, master mechanic of the Plains Division on the S. P. & W., raised his voice slightly. He could only be heard about a block away.

ROBBING PETER

"THE cost of turning engines at Plainville is running too high, much too high. It'll have to be reduced!" H. H. Carter, master mechanic of the Plains Division on the S. P. & W., raised his voice slightly. He could only be heard about a block away. When he got really worked up and going good he didn't really need a telephone for anything under a mile.

"Well, seems like we are doing the best we can," Jim Evans, the roundhouse foreman, replied, "but I'll see if we can't shave a little off of it."

"Try nothing—it's got to be done! If we run over our allowance about one more time, there'll be some new faces around here! . . . Now, about those engine failures. . . . "

Evans bit off a chew of horseshoe and braced himself. Carter hated engine failures worse than a machinist hates putting up binders.

"Now mind, we've got to cut the cost of turning engines and have fewer failures," the master mechanic admonished as he left the roundhouse an hour later.

"How are we coming on this month's showing?" Evans asked John Harris, the clerk, after Carter had left.

"Nearly three hundred dollars over," the clerk replied.

"Hell and high water!" Evans replied, "and this only the ninth. Well, I don't see how in the devil I'm going to cut much. I'll have some of the men charge time to classified repairs; that'll help a little." Evans strode out the door and headed for the roundhouse.

He noticed Cox, a machinist, and his helper sitting in the cab of the 5094. He also noticed that the right middle connection bushing wasn't in and the machinist had had time to finish the job without rushing. "How you coming on her?" the foreman asked the machinist.

"Waiting on the drill press man to get it drilled," Cox replied.

Evans went to the machine shop to see what was causing the delay. He found the drill press man sweating and swearing. Work was piled up all around him with more coming in all the time. Simpson, the drill press man, was working at top speed, but the drill press wasn't. Evans could almost count the revolutions of the drill as it turned.

"What's the trouble, Simpson? That fast as the drill will stand in brass?" Evans asked.

"Hell, no; but it's fast as it will run. The high-speed clutch won't hold and I have to run it at slow speed." The drill press operator was plainly peeved.

"Didn't we order some repair parts for the drill press some time ago?" the foreman asked.

"Yes, the storekeeper ordered them, at least he said he did, but they never did get here. If they did, I didn't see them."

Evans drowned a fly with a sluice of tobacco juice and started for the storeroom. "What's the trouble we can't get repair parts for the drill press?" he asked the storekeeper.

"Don't make 'em any more," the storekeeper replied. "That drill press is as out of date as red flannel underwear."

"Well, how about piston rods for a 5000? Are they out of date too?"

"Ought to have them in the next car. I'll let you know soon as I get the bills."

The foreman grunted a reply—his mouth was too full of tobacco juice to speak—and went back to the roundhouse. He stopped at the drop-pit to see how things were going there. Jenkins, a machinist, and his helper were wrestling with a boring bar in the right cylinder of the 5086.

by

Walt Wyre

"Are you about to get her?" Evans asked the machinist.

"Well, it ought to fit at one end or the other. The blamed thing cuts tapering," Jenkins replied. "We've been on this pair of cylinders long enough to have bored half a dozen if we had the right kind of boring tool."

"Yeah, it's a little rough too." Evans leaned over and felt the inside of the cylinder.

"I'll say it's rough. By the time the tool marks are worn out, it'll need reboring again, but it's the best I can do with this boring bar. The blamed thing chatters like a model T in loose sand."

Evans went on down through the house trying to figure some way that cost of turning engines could be reduced. "Now, let's see; I might cut off a couple of laborers, a coppersmith, two machinists and helpers, and a boilermaker and helper. That'll be about forty dollars a day." Evans frowned and spat as though the cud of horseshoe in his left cheek had quinine in it. He turned suddenly and started towards the office. "Might as well have the clerk make the bulletin out and get it over with."

Evans instructed the clerk to make out the bulletin and put it on the bulletin board. "Might as well make the cut effective Monday. We have to give them forty-eight hours notice anyway and that'll just be one extra day not counting Sunday."

THE foreman sat down at his desk and was looking over work reports when Bart Hudson, the lead boilermaker, came in. "Say, Mr. Evans, the 5074 is due for a flexible staybolt cap removal. How about getting the jacket and lagging removed?"

"All right, all right!" Evans' voice sounded like Major Bowes talking to an amateur that had just gotten the gong. "Tell Malone to get on it right away."

Harris finished typing the bulletin, read it over, and started out the door with the paper in his hand.

"Hey, wait a minute," Evans stopped the clerk. "We'll have to change that a little. With that five-year test coming up on the 5074, I can't cut off a coppersmith or a boilermaker. Wait until tomorrow. Maybe something will come up." The foreman picked up a pad of yellow clip and began figuring. Three hundred dollars over already. A little over thirty dollars a day he was running over. That meant a reduction of about forty-five dollars a day if he stayed within the allowance for the month. Even if he cut off the two laborers and the two machinists and helpers that wouldn't near make it, just amount to about half of it, in fact. The foreman leaned back in his chair and propped his feet on the desk. He could think better in that position.

The phone interrupted his thoughts. "Roundhouse clerk talking," he heard Harris say. "O.K., I'll call you back and let you know what engine.—Old guess-and-grumble wants a 5000 for an extra west about twelve-thirty," the clerk told Evans. "What'll I give him?"

Evans' feet hit the floor with a thump. "I'll let you

know in a little bit soon as I look things over. May use the 5074; she can get back without running over her inspection date."

When Evans got to the roundhouse he found that the 5074 was out of the question. A boiler stud twisted off; wouldn't be time to get it without a delay.

"Well," Evans said to himself, "I'll use the 5081 and run the 5074 on the passenger instead." He walked down to stall fourteen where the 5081 stood. The piston valve out of the right side was lying on the front end of the engine. The valve bushing was lying on the floor nearby. There was a jagged gash cut with the carbon arc lengthwise of the bushing. Evans beat it to the machine shop to see if the new bushing was about ready to be put in.

It wasn't; in fact, work on it had not started. The casting was lying on the floor beside the lathe. Evans looked at his watch. Well, the 5081 was out, too. The engine on the extra would have to be run through or else the dispatcher would have to take a 2800. He went back to the office to tell him about it.

EVANS sat on one corner of the desk and picked up the phone. "Say, how about a 2800 on that extra?"

The dispatcher sputtered like a piece of hot iron dipped in water. "No; couldn't make the time. Eleven coaches with a 2800? We'll have to use a 5000 and a blamed good one, too."

"Where you think I'm going to get one on such short notice? Think locomotives come in cans?" Evans asked.

"If they did, you fellows would have a delay hunting the can opener," the dispatcher cut in sarcastically. "And say, this extra is pretty hot stuff. A load of government officials, some of them high-powered, too. If you get a delay on it, I imagine you'll hear about it."

"What's coming in on her?" Evans asked.

"The 5083," the dispatcher told him.

"O.K., we'll just have to run her through. Notify the crew to stop the train by the roundhouse. Would you by chance be able to tell me definitely when to look for it?" Evans grinned slightly at his thrust at the dispatcher.

"Ought to be in at one-thirty-two and ten seconds." The telephone clicked as the dispatcher hung up.

"About as funny as a boil on the back of your neck —the dispatcher, I mean," Evans growled as he sat down at the desk. He still hadn't figured out how to save about forty-five dollars a day for the next twenty days and still keep engines going. Sitting and thinking wasn't doing any good, he decided, and went back to the roundhouse.

On his way through the roundhouse, Evans ran into two machinists with their helpers leaning against a locomotive talking. "What's this, a convention?" he asked.

"I'm waiting on machine work—valve bushing," Cox, one of the machinists, said.

"And I'm waiting to get a main rod bushing drilled," the other machinist told him.

"Well, see if you can't be doing something else while you're waiting."

Evans went to the machine shop. The drill-press operator was snowed under as usual, work to be drilled lying all around. But he was evidently doing the best that he could under the circumstances, so the foreman said nothing. Every machinist in the shop was busy. He walked over to the lathe where one of the men was taking a cut on a valve bushing. The cut being taken was very light.

"Last cut?" Evans asked.

"No," the machinist replied, "got to make one more. The lathe is just too light for this heavy work, and Martin is turning a piston in the big lathe." The machinist pointed to the machine mentioned, a belt-driven lathe that must have been a good one when peg top pants were in style.

Machine work was piled all around waiting to be done—rod bushings to be turned, a set of cross-head bolts in the rough to be finished and threaded, a main pin to be turned, among others.

A pair of babbitted crossheads lay waiting at the big planer. A machinist was making a piston-rod key in the big machine and a slow job it was, but the small slotter ordinarily used for such work had been broken down for several months. It was another heirloom handed down from some closed down backshop on the system. It had been in Plainville so long that Evans had forgotten where it came from.

Over at the boring mill a machinist was having some fun with a driving-box. The feed on the machine was worn out and had chosen not to run. Evans surveyed the scene a few minutes, then, seeing there was nothing that he could do to help the situation, went back to the office.

"The dispatcher said for you to call him," the clerk told Evans.

Evans swore and picked up the telephone.

"The 5083 is falling down," said the dispatcher. "The engineer says she's not lubricating; wouldn't pull a relief worker loose from his shovel. How about digging up another hog?"

"There ain't another one," Evans replied, "unless you could use a 2800."

"We don't run trains by the calendar," the dispatcher retorted.

"Hell, no! A calendar is always right!" the foreman snapped. "We'll just have to see what can be done with that lubricator while she's being worked," Evans added and hung up.

"Now ain't that nice!" he told the clerk. "Me trying to figure out how to save forty-five dollars a day with no prospects for saving a penny without neglecting work that should be done and an engine failure staring me in the face. Well, that's that! Guess I'll go eat; maybe things will look better."

THE foreman left word for a machinist and helper, the cellar packer and rod cup man to work through noon hour to get the 5083 when it came in on the Special. He rushed back from lunch so that he would be there when the engine came in. But things didn't look any better. The 5083 was steadily getting worse and losing time. The Special wouldn't be in until about one o'clock. "And all that extra time from working the men noon hour, too," Evans growled.

Just as the one o'clock whistle blew, the smoke of the extra showed in the distance. It was ten minutes past one when the engine reached the roundhouse.

"How's she doing?" Evans asked the engineer.

"Not worth a damn! She's not lubricating, the cylinders are dry and blowing bad."

"Why didn't you add some oil?"

"I did, when we stopped for water at Middleton. She done very well for awhile. The trouble is the oil gets too hot, boils and foams. Ought to use saturated steam instead of that superheated steam from the turret to heat the lubricator. Everything else looks pretty good," the engineer added.

Evans fished in his jumper pocket for his plug of horseshoe. His brow wrinkled and he squinted one eye.

He found the chewing tobacco and bit off a hunk. "Disconnect that pipe at the lubricator connection," he told the coppersmith, "and put a choke in the line. Leave about a sixteenth of an inch opening for steam."

While the coppersmith was fixing a plug to fit the lubricator steam pipe connection, the lubricator was filled. Evans pumped oil to the cylinders by hand and then told the supply man to replace the oil he had pumped out of the lubricator.

The engine was serviced and ready to go when the coppersmith returned with the choke he had improvised for the steam line. He had cut a washer that would fit in the connection and drilled a $\frac{1}{16}''$ hole in it.

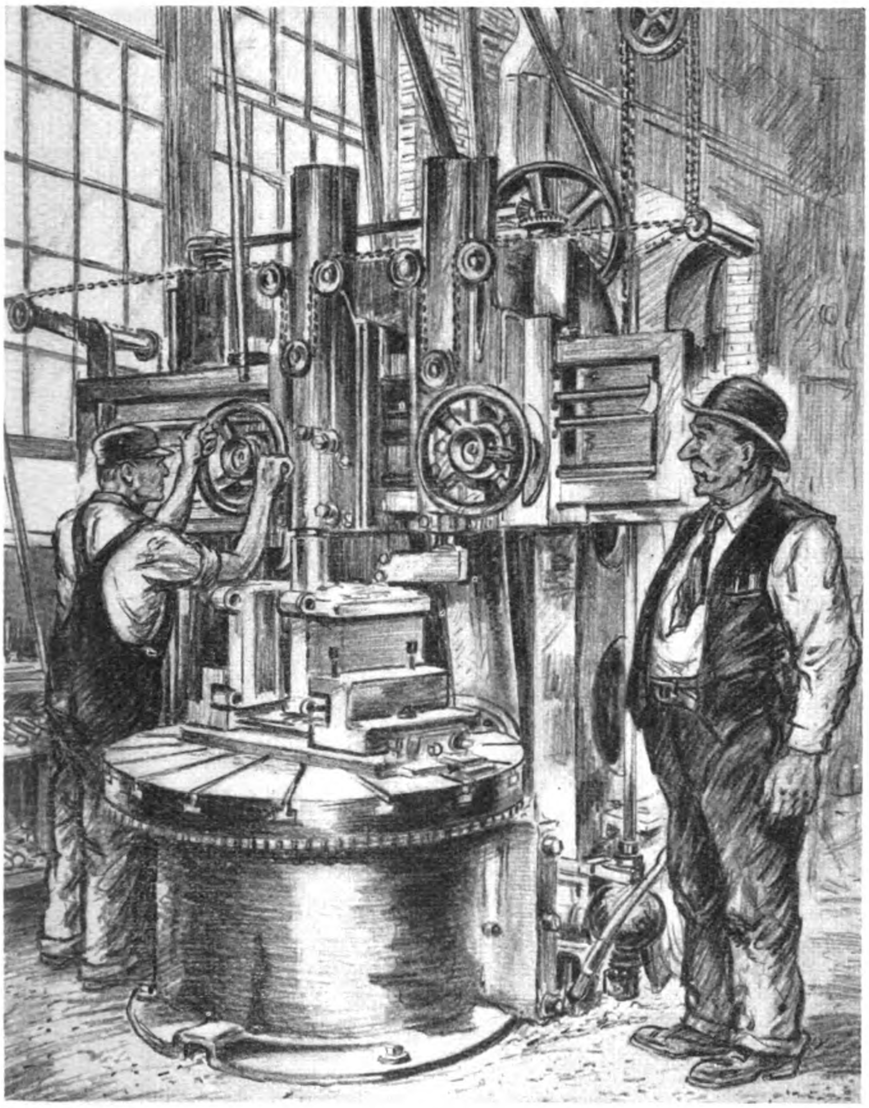
"What do you say?" the engineer asked. About ready to go?"

"Yes, go ahead and get on the train," Evans replied. "Ride down with him and connect up the lubricator heater pipe while they're testing the air," he told the coppersmith.

"Think they'll make it?" the clerk asked when Evans reached the office.

"Well, I don't know. Might, if that hoghead will use a little judgment. I gave him some extra oil and put a choke in the lubricator steam line. It ought to work O. K. At least, I hope so," the foreman said fervently. "If it does, I've still got the allowance to worry about. If it don't make it, I wouldn't be surprised if I didn't have a new job to worry over—how to get one, I mean." He left the office and went over to the roundhouse.

Things were going somewhat better than they had been before noon. The men in the machine shop had gotten out enough of the accumulated work so that the ones on running repair could get to work, and they were working, Evans noticed with a feeling of satisfaction. But that didn't reduce the cost of turning engines.



Evans surveyed the scene a few minutes, then, seeing that there was nothing that he could do to help the situation, went back to the office

When it came time to go home at seven o'clock that evening, the foreman still had figured no way to make a substantial reduction. The next day was a repetition of the one preceding. Men on running repair tore the work down, then waited on machine work.

About two-thirty, the master mechanic called up and told Evans to come down to the office. The foreman gathered up an armful of files and correspondence on things he thought possibly Carter would want to know about and headed for the office.

"Well, have you figured out how you can cut down within your allowance?" the master mechanic asked.

"Not enough to do any good. Of course, I can cut a dollar here and there——"

"Why can't you cut down? Other railroads are doing it. We ought to be able to turn engines at a cost to compare with them. Look here." The master mechanic shoved a typewritten chart showing comparative costs of turning engines of various railroads at roundhouses somewhat similar to Plainville.

Evans studied the chart a moment before replying. "Yeah, we're a lot higher than some of them. Wonder if the ones showing low costs hitch horses to their automobiles?"

"What do you mean?" Carter snapped.

"Well, I might as well let you have what I'm thinking now as later," Evans said hesitatingly. "That's what we're doing here on the S. P. & W. We've got some good locomotives, some of them fairly new and I understand they are buying some more new model streamlined equipment, right up to now. But, in our roundhouse, we're still driving a horse."

"What are you getting at? Talk sense," the master mechanic snapped.

"Well, to be perfectly frank, we are trying to make repairs on new style motive power with old style equipment. We're doing it, too, and a good job if I do say it, but we could do a blamed sight better job if we had tools in line with the work we are doing."

The master mechanic listened while Evans explained the situation. When the foreman had finished, Carter

said, "Yes, we need new tools, new equipment, but I don't see how we are going to get it.

"But what I wanted to talk to you about is the company is spending a lot of money on track repairs, over two million dollars getting ready for faster trains. They are sending some machines up to be overhauled, a pile driver, a couple of tie tampers, and a ditcher. Want to get them soon as possible."

"O. K., we'll get them." He grinned just a little as he said it. He had found a way out of his overrun allowance. "And I think I can make some reduction in cost of turning engines, but remember about the machines we need."

"All right, I'll remember, and don't charge so blamed much time to them track machines that the division engineer will think he's getting new ones." The master mechanic had been a foreman himself.

Inspecting and Repairing Oxy-Acetylene Equipment

Repairs to oxy-acetylene equipment on the Pennsylvania System is centralized at Wilmington, Del., Altoona, Pa., Pitcairn, Pa., and Columbus, Ohio. These repairs for the Central Region are taken care of at the Pitcairn Air Brake Shop. Repairs of any nature are not permitted at outlying points, instructions being to the effect that the equipment be forwarded to the designated shop for the necessary repairs. Regulators must be sent in every six months, and torches at such time as they fail to function properly. For identification purposes, and as an aid in tracing shipments, the triplicate repair tag, mentioned in the article on pneumatic tools, which appeared in the January *Railway Mechanical Engineer,* page 32 is used.

Regulators

Various types of regulators are in service, but a description of the methods and practices for any one type will suffice. When regulators are received for repairs, an inspection is made previous to dismantling, for the following: Nipples broken off at connection to body; inlet connection nut worn or so damaged as to prevent holding the regulator tight on the cylinder valve; inlet connection gland loose at the filter, or with bent, broken, or damaged seat so it will not make a tight joint with the cylinder valve; filter loose at the connection to the body or to the adapter or filter bent or damaged so as to cause it to leak; safety-valve stud loose at body connection, or bent or broken; bottom cap damaged so as to prevent removal without injuring the regulator body; spring case loose or threads stripped so as to prevent holding an adjusting screw.

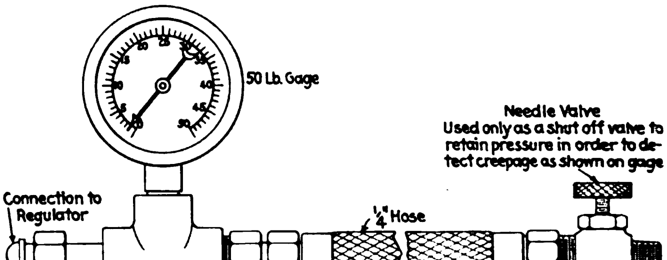
When dismantled, the parts are cleaned with turpentine substitute or tetrachloride, extreme care being taken not to permit oil or grease to get on any of the parts or connections. The gages are removed and tested on a test rack. As a coating of litharge mixed with glycerine in the form of a paste is applied to the connections at the time of assembling, it becomes necessary to heat the connections by means of a welding flame in order to effect their removal from the regulators.

The bottom cap is removed by holding it in the vise and turning the regulator body to the left by hand. A light jar with the hand on the filter assembly will loosen the joint, care being taken not to tighten the vise sufficiently to crush the cap. The adjusting screw is turned to the right until the pressure on the stirrup cap is released, then the stirrup cap is removed with a screw driver, following which the equalizing pin seat and holder and spiral seat spring are removed. In case the seat and holder stick, they can be pulled out with the eraser on the end of a lead pencil. If the spring case threads are stripped, so that a good adjusting screw will not hold, the threads are drilled out, and a shoulder bushing sweated in place, which brings the threads back to the standard size again, so as to fit a standard screw.

In case the threads in the spring case are pulled or otherwise damaged, they are retapped with a ½-in. 13-thread U.S.S. tap. The usual procedure is to clamp the tap in a vise with the regulator above it, thus turning the regulator on the tap. This method is used as an aid in preventing chips from lodging in the regulator body. If the ball seat of the adjusting screw is dirty, nicked or badly worn, it is cleaned with No. 00 emery cloth. Such conditions cause the gage hands to vibrate and must be eliminated. Bent screw handles are straightened by means of a wooden mallet. The inlet nut and swivel, as well as the hose connections, are renewed, if damaged, the nipples being sweat soldered in place. The hose-connection gland seat, if damaged or leaking, is reseated with a reamer which is lubricated with thick soapy water during the operation and litharge and glycerine is applied to the threads when it is placed in the regulator body.

Special attention is given to the fit of the valve holder in the nozzle. If it is tight, it is dressed with fine emery cloth, and if ridges appear in the nozzle bore, the nozzle is nenewed. These defects, as well as that of the stirrup binding in the back cap, causing friction, will result in what is known as "zero leak," "hum" or "excessive static creep" of pressure.

Repairs to the valve seat in the holder are made by placing the holder in a small bench lathe, facing the seat true, polishing with a piece of crocus cloth, and buffing with a rag. If the seat is in fairly good condition, it



Test device used in determining leakage in regulators

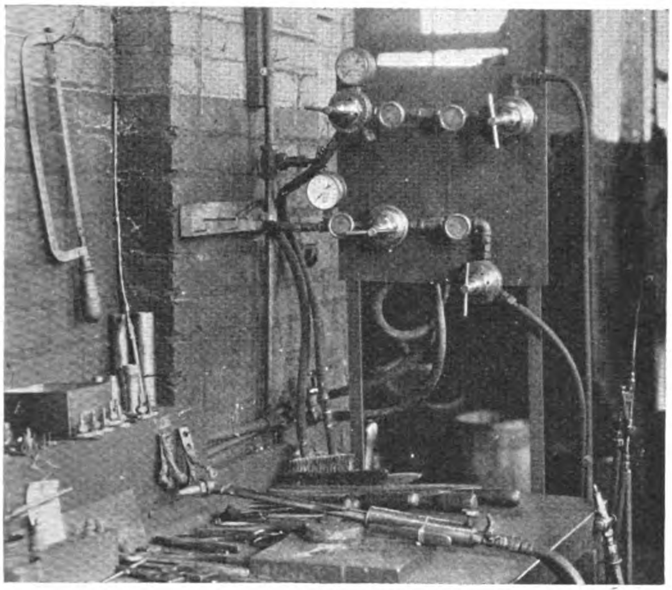
may be cleaned with an ordinary eraser. The nozzle seat, if necessary, is reamed, faced with a piece of crocus cloth rolled, and finished with a piece of cloth. An eraser is used in case the seat is in good condition. The compensating spring is carefully inspected, and if weak or corroded, is renewed. Building up of pressures beyond the adjustment of the regulator results if the defects mentioned are not taken care of properly. The equalizing pin is inspected for worn or flattened ends and hammered sides and it is renewed if damaged to any extent. If the stirrup cap has more than one central impression for this pin, or if the stirrup cap is otherwise damaged, it is renewed. The stirrup is carefully examined for bulging sides, stripped threads, or damaged wedge-shaped ends. The nozzle hole is gaged to determine whether or not it is the proper size. These sizes on cutting and welding regulators are ⅛ in. diameter and $\frac{1}{16}$ in. diameter for cutting and welding, respectively.

Particular care is exercised to see that the stirrup and stirrup cap do not drag in the bottom cap, and that the

gasket shoulder on the cap is in good condition. A new type of compensating spring, known as the spiral-seat spring has been developed, as an aid to prevent "humming" at certain pressures. This is installed with the small diameter toward the nozzle and the large diameter toward the seat, the coil end being bent inward sufficiently to prevent scraping or binding on the nozzle sleeve. The safety cap is inspected to see that the threads are in good condition, the disc shoulder not damaged, and cap not plugged up. If the safety-valve seat is rough or corroded it is cleaned with crocus cloth. Following repairs and previous to assembling, regulators are blown out with filtered compressed air free from oil or moisture.

Assembling Regulators

The spiral seat spring is placed, as previously stated, with the small diameter toward the nozzle, in the nozzle sleeve. The seat and the holder are put in position, with



Bench and test rack used in repairing regulators

the black seat to nozzle, and is pushed down on the nozzle and then released, to see that the parts are free. The adjusting screw is inserted for a few turns and the regulator held with the nozzle and stirrup pointing upward. The equalizing pin is placed in the holder and stirrup cap screwed down on the stirrup. As the stirrup has split ends, particular care is required in order to avoid crossing the threads, the projecting ends of the stirrup being held together sufficiently to obtain a full thread for the cap and, when screwed up, the wedge ends of the stirrup are held tightly in the vee joint of the cap. The regulator is then held in such a manner that the equalizing pin will center in the cap, so that the cap will not catch on the nozzle sleeve end. The stirrup cap is then tightened with a screw driver and the adjusting screw released so that the nozzle will move with a slight touch of the fingers. The stirrup is twisted back and forth to make sure that it does not rub on the nozzle bridge. The bottom cap gasket is moistened with water and placed on the cap, which is then placed on the regulator body and turned back and forth a few times, to insure that it does not bind on the stirrup or stirrup cap. The regulator is now placed with the cap held in a vise, and the regulator body tightened on the cap by hand. An examination of the safety valve is made to make certain that the proper disc is applied, and that the ports in the cap are open. Pressure gages which have received the necessary test and repairs are placed on the regulator connections, an application of litharge and glycerine being put on the threads.

Testing Regulators

Testing equipment consisting of three oxygen cylinders is used for testing regulators, one for oxygen regulators, one for acetylene regulators, and the third for the purpose of re-checking low-pressure gages when necessary and for making a soap suds test for diaphragm leakage on certain types of regulators. A short hose connection is used, one end of which is attached to the outlet of the test rack regulator and the other end to the outlet of the regulator on test, permitting an outlet from the cylinder to the low pressure gage. When the pressure in No. 1 cylinder has been reduced to 1,500 lb., it is replaced by a full cylinder, and the partly used cylinder takes the place of No. 2 cylinder when that one becomes empty.

The procedure in testing oxygen regulators is as follows: The regulator to be tested with the tension released on the adjusting screw is applied to No. 1 cylinder, and the cylinder valve opened slowly. A soap bubble is now placed on the regulator outlet connection to determine whether or not a "zero" leak exists. This would be due to the regulator seat leaking, and if an examination shows that the seat is in good condition, the cause of the leakage is probably due to the seat being low, which can be corrected by placing layers of writing paper beneath the seat to bring it to the desired height.

A test device is next attached to the outlet of the regulator on test. Tension is put on the adjusting screw until a pressure of 30 lb. registers on the gage of the test device. Sufficient time is allowed for the pressure to settle, and the gage is watched for any increase in pressure for a period of three minutes, which increase should not be over 5 lb.

A decrease or increase in pressure at this time is caused by the diaphragm leaking, or parts in the valve or nozzle assembly binding or rubbing, which serves to prevent the valve from seating properly. If the diaphragm is of the soldered metallic type, a test is made as follows: Remove the adjusting screw and spring case, attach outlet end of regulator to the outlet on No. 3 cylinder by means of a hose connection. Pressure is then turned on and is against the diaphragm. Any leakage can be detected with the aid of soap suds. This method also has the desirable effect of resetting a diaphragm which has buckled, due to the fact that the pressure strikes the diaphragm in an opposite direction than when operating normally. If the diaphragm is one of the composition type, a visual inspection will determine whether or not it is in good condition.

Acetylene regulators are tested on No. 2 cylinder and the above practices prevail, except that not over 200 lb. pressure is used during the tests. Soap suds is applied to regulators during the tests and all leakage eliminated. After passing tests regulators are prepared for shipment as follows: The adjusting screw is removed and wired to the regulator; the inlet connection is wrapped with heavy paper to prevent dirt from getting into the regulator, and the regulator is placed in a wooden container for shipment.

Approximately 300 regulators are repaired each month at the Pitcairn Shop.

Repairs to Torches

Various types of torches are repaired, but a description of the practices on any one type will suffice, as the principle is practically the same on all types. There is no specified period of time for torches to remain in service, but they are sent to the central shop at any time

that they fail to function properly. As in the handling of regulators, a repair tag is used to facilitate shipping and identification of the sending shop. When received at Pitcairn they are carefully inspected for the following: Leaking valve seats; leaks at soft soldered connections on the base; leaks at the hard soldered connections on the tip head; leaking tubes; leaks at the valve-stem packing glands or nuts, hose-connection inlet gland, or tip retaining nut in the tip head.

Careful attention is given the tapered seats in the tip head, to make sure that they are free from dents or distortion. A test for leakage is made in the following manner: The oxygen and acetylene hose on the testing device are connected to the torch, pressure adjusted, flame lighted on the tip end, and the torch submerged in a water bath. Bubbles will reveal the sources of any leaks which may exist while the fact that the torch body is submerged, prevents any danger of explosion due to leaks in the open. Following test and inspection the torch is dismantled in approximately the following order: Tip and retaining nut, valves in base, high-pressure unit, base removed from the tubes and the handle assembly taken from the tubes. Damaged needle-valve seats are reamed by means of a flat-bottom reamer which insures proper alignment of the seat with the stem of the valve. Screw taps are used to clean dirt from and relieve strain in the threads. A drill or wire of sufficient size is used to remove dirt or other foreign substance from all by-passes and compressed air, free from oil or moisture, is blown through to remove fine particles. Damaged valve stems are replaced and all valve-stem assemblies are packed with 1/8-in. standard graphite packing. Damaged high-pressure valves at the nozzle are reamed with a special tool and damaged seats are replaced. Oxygen and acetylene hose connections, if damaged, are replaced with new ones which are screwed into the base and flame-soldered.

Tubes and Head Assembly

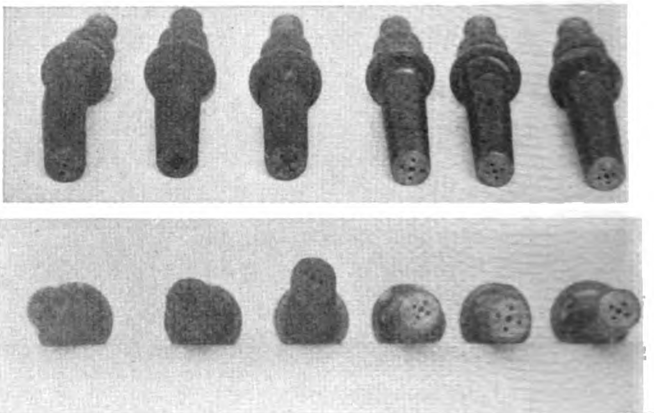
By-passes are cleaned as previously described, with a drill or piece of wire and blown out with compressed air. Bent tubes are straightened and, if, bursted, are withdrawn and replaced, all tubes being hard (silver)-soldered to the tip head, due care being taken to see that the pre-heat gas tubes as well as the acetylene supply tubes are of a copper alloy.

The supply tubes in cutting torches are, as a rule, not less than 14 in. long, to insure safety and comfort to the operator. Any necessary reaming is performed on the tip head seating surfaces, when dented or distorted, while suitable screw plugs and taps are used to repair threads in the tip head and tip retaining-nut screw threads. Damaged tip retaining nuts are replaced. All bent or broken handles are reclaimed by straightening or welding, if their condition so requires.

A repairman's bench showing the tank in which torches are submerged while being tested for leaks

Torch Tips

All tips are carefully examined for clogged by-passes, marked seating surfaces, strained and stripped screw threads, being bent out of alignment, and as to the condition of the hexagon wrench hold on the body for tightening the tip in the head. The by-passes on the flame end of the tip are checked to conform to standard sizes. Clogged by-passes are cleaned with a drill of such size as will not enlarge the opening. Bent tips are straightened with a hammer, while those having strained or stripped threads are renewed. The removal of marks on seating surfaces and the cleaning of the bodies is accomplished by means of a high-speed motor equipped with suitable fixtures to fit the tips, a buffing and emery process being employed.



Two views of defective torch tips as received for repairs (three at left) and after having been repaired (three at the right)

Orifices in the flame end of tips which are oversize are wedged and re-drilled to the proper sizes, and the orifices in the gas mixer end are cleaned. All tapered seating surfaces on the gas mixer end are freed of marks, or anything that would interfere with the tight seating of joints, so necessary for the proper functioning of an efficient torch tip.

Torch-Tip Head

The joints are soldered with silver solder to guarantee tight joints at high temperatures. The tapered seating surfaces in the tip head become distorted and coated with carbon. This condition is remedied by the use of a tapered reamer, soapy water being used as a lubricant for cutting. When the tip retaining-nut screw threads in the tip head become strained or distorted, they are repaired by means of a screw plug of the proper size, the outside of the thread connection being hammered to re-form it to shape.

Assembling Torches After Repairs

After the repairs are completed the torch parts are assembled in the following order: The handle grip and tube; tube assembly and base (soft-soldered with acetylene flame); hose-connection glands and base (soft-soldered with open flame); oxygen and acetylene needle-

valve-stem assembly; handle-grip assembly adjusted to tubes and base (using machine screws to hold them in place); high-pressure trigger-valve handle replaced and adjusted; tip and tip-retaining nut fitted to head.

Testing Torches

When the torch has been assembled, the oxygen and acetylene hose on the testing device are connected to the torch. Pressures are adjusted and the torch lighted in the following manner: The oxygen valve is opened and left open; the regulator valve on the test device is opened slowly until the pressure gage shows the correct working pressure, then the oxygen valve on the torch is closed. Next, the acetylene valve on the torch is opened and left open; the acetylene regulator valve on the test device is opened slowly until the low-pressure gage shows the correct working pressure. The torch is lighted and held in a downward position and not in the direction of other workmen. (*The acetylene is always allowed to flow through the torch for two or three seconds before applying the lighter to the tip in order to avoid back firing.*)

Next, the oxygen valve on the torch is opened and the flame adjusted.

A test is made for leaking joints by submerging in a bath of water. If leaks occur, proper adjustment is made at the packing nuts, soldered joints, and tapered seats in the tip head. The character of the flame is noted, as all cutting tip and pre-heating flames should burn uniformly. The trigger handle is pressed, and while the oxygen flame is burning from the orifice in the center of the tip, it is noted whether or not it travels in a straight line with the tip.

Tests, Causes of Trouble, and Remedies

1—*Nature of trouble*—Low-pressure gage shows correct pressure, but sufficient acetylene does not come through torch.

Reason—There is probably carbon in the mixer.

Remedy—Remove the mixer and clean it with soft annealed wire.

Reason—Possibly carbon in the valve.

Remedy—Clean the valve carefully, using only soft annealed wire.

2—*Nature of trouble*—Low-pressure oxygen or acetylene gages show correct pressure, but sufficient gas does not pass through torch.

Reason—Possibly dirt in the screen.

Remedy—Remove and clean the screen.

3—*Nature of trouble*—Oxygen leaking through the center orifice in the cutting tip when the cutting valve is closed.

Reason—Valve seat is leaking.

Remedy—Clean the valve seat, and if this does not correct the trouble, reseat or renew the seat.

4—*Nature of trouble*—With correct pre-heating flame on the cutting torch, flame is blown out when cutting-jet valve is opened, or the torch shows an oxidizing pre-heating flame.

Reason—Leak at the tip seat in the torch head.

Remedy—If the tip cannot be reseated, apply a new one. In an emergency out in the field, it may be possible to remedy this defect by chalking the tapered seating surfaces, which has the effect of filling up the crevices.

Following the tests, the torch is shut off as follows: The oxygen valve on the torch is closed first then the acetylene valve, after which the cylinder valves are closed. The torch valves are then opened to release the pressure on the gages, after which the regulator-valve screws are released. After this is done the torch is turned over to the stores department for shipment.

Approximately 80 torches a month are repaired at the Pitcairn Shop.

Hose and Hose Connections

Leaking hose or connections are not used, as a small jet of oxygen striking a workman's clothes may cause them to ignite from a spark and result in a severe burn. Hose and connections are tested daily for leakage, after the pressure has been properly adjusted to the torch, by closing the cylinder valves, keeping the torch valves closed, and noting whether or not any drop in pressure occurs on the high-pressure gage. If such a drop occurs, the leak is located by the use of soap suds, testing the hose, torch, and connections.

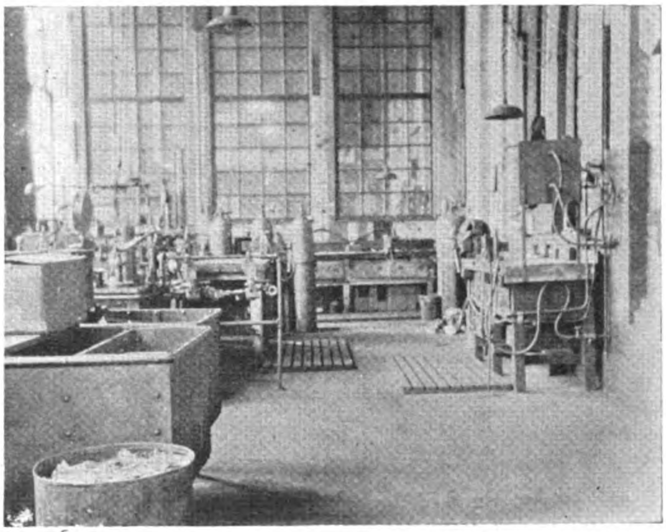
Hose connections are coated with shellac before being placed in the hose, and are well secured with clamps. A hose that has been used for acetylene is not used for oxygen, and vice-versa.

In case of a back fire in a hose, the cylinder valves are closed immediately, the acetylene first. With the valves closed, the hose in which the back fire occurred, is disconnected from the regulator and torch and laid aside for 20 min. at least. If, at the expiration of this time, the hose is cool to the touch, and there is no smoke issuing from it, or any sound or other indication of fire in it, the hose is blown out with compressed air, first making sure that the air is free from oil or moisture, after which the hose is allowed to remain for about 20 min. longer, at which time, if there is no indication of fire, it is placed in service. As a rule, hose in which a back fire has occurred will contain burned rubber, which may be carried to the torch screen or valve, resulting in clogging of the torch. It is often necessary to cut out the burned section.

Regulators and Gages

High-pressure regulators and gages are used on all cylinders from which gas is being used, and low-pressure regulators and gages on all welding or cutting connections to generator pipe lines. Regulators and gages which have been used for oxygen are never used for acetylene and vice-versa.

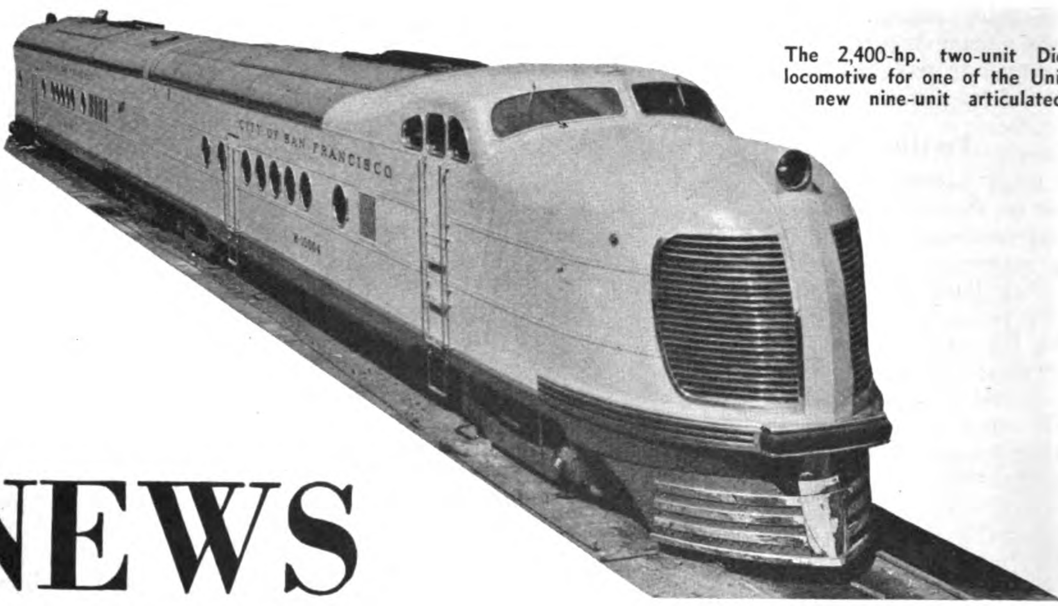
Particular care is exercised to prevent grease from



A general view of the department where oxyacetylene equipment is repaired

getting in or around the regulators, gages or fittings, as the oxidization which occurs when oxygen comes in contact with oil or grease may cause a fire or an explosion. Regulators with broken glasses are taken out of service and sent to the shop to be repaired. Welders and cutters are not permitted to make repairs.

Supervisors are required frequently to inspect gages showing working pressure, to see that the hands have not been sprung back, allowing considerable pressure of gas to pass through the gage before it starts to register, permitting workman to use higher pressure than that shown on the gage.



The 2,400-hp. two-unit Diesel-electric locomotive for one of the Union Pacific's new nine-unit articulated trains

NEWS

Colonel B. W. Dunn Dies

COLONEL B. W. Dunn, who retired on February 1, 1935, as chief inspector, Bureau of Explosives, Association of American Railroads, died on May 10 at his home in New York. He was 75 years old.

Streamliner City of Los Angeles Delivered

THE streamliner City of Los Angeles of the Union Pacific was completed and sent out of the shops of the Pullman Standard Car Manufacturing Company on April 21, and after being exhibited in Chicago on April 22 and 23 departed for Los Angeles, from which city it began its 39¾-hr. schedule on May 15.

How Fast Are We Going?

THE use of speedometers in the solariums of the streamline trains and in day coaches of some other through trains is the latest novelty offered by the Boston & Maine. The first train to be so equipped will be the "Flying Yankee," between Boston and Portland, and beyond over Maine Central lines to Bangor, Me. The speedometer will be illuminated, and will have a clock included on its face.

All Available Automobile Cars Being Used

ALTHOUGH the railroads have been steadily increasing their supply of cars suitable for shipping automobiles, "all of such cars as well as the highways and water routes" are being used just now "to the limits of their capacity" to care for the current factory sales of automobiles, according to a recent statement issued following a meeting at Detroit, Mich., of the traffic managers of companies affiliated with the Automobile Manufacturers Association. The foregoing followed a reference to reports received at the meeting which "indicate that thousands of freight cars formerly used in transporting automobiles are no longer in service."

Mechanical Division Announces Meeting Place

THE Mechanical Division, Association of American Railroads, has announced that the 1936 annual meeting, scheduled for June 25 and 26, will be held at the Congress Hotel, Chicago. The meeting will convene at 10 a.m. Eastern Standard Time on the first day and 9 a.m. on the second day. The program will be completed by noon on June 26, if possible.

Boilermakers To Meet in September

THE annual meeting of the Master Boilermakers' Association will be held at the Hotel Sherman, Chicago, September 16 and 17. It will be strictly a business meeting at which a revision of the Constitution and By-Laws of the association will be discussed, as well as subjects of papers for later presentation.

Chicago-Denver 16 Hours

THE Chicago, Burlington & Quincy, on May 31 established 16-hr. daily train service between Chicago and Denver, when it transferred Zephyr No. 1, then operating between Lincoln, Neb., and Kansas City, Mo., and its Mark Twain, then operating between St. Louis, Mo., and Burlington, Iowa, to the Chicago-Denver line. These trains will be operated between Chicago and Denver until the 12-car Denver "Zephyrs" are completed about the latter part of July. This move is an effort on the part of the Burlington to capitalize on summer business and to protect its Chicago-Denver mail contract. The time table provides for departure from Chicago at 5:30 p.m. and arrival in Denver at 8:30 the next morning (1,034 miles at 64.63 m.p.h.). Departure from Denver will be 4:00 p.m. and arrival in Chicago at 9:00 a.m. The trains will be known as the Advance Denver Zephyrs.

The former service provided by these trains is now furnished by steam trains.

"Super Chief" Placed in Service

THE "Super Chief" of the Atchison, Topeka & Santa Fe was placed in service between Chicago and Los Angeles on May 12, on a schedule of 39 hr. and 45 min., leaving Chicago at 7.15 p.m. Central Time. Its inauguration was celebrated by a triple birthday party held in the Dearborn Street station just before departure, the occasion being the birthday of the new train and the anniversaries of Samuel T. Bledsoe, president of the Santa Fe, and his daughter, whose birthdays fall on May 12.

R. & L. Historical Society to Hold First New York Dinner

THE New York Chapter of the Railway & Locomotive Historical Society will hold its first annual dinner at the Columbia University Club, New York, on June 11. The members are to be entertained with moving pictures of some of the country's fastest trains and an exhibit of model locomotives to which the Baltimore & Ohio is to contribute.

New York Central Streamliner "The Mercury"

THE New York Central's new streamline high-speed train to be placed in service on a daily round-trip schedule between Cleveland, Ohio, and Detroit, Mich., via Toledo, Ohio, will be named "The Mercury."

The train, air-conditioned throughout and embodying many innovations in appointments and mechanical features, will be placed in service some time this month following an exhibition tour covering several cities. Especially in its floor plan and decorations will The Mercury differ materially from any existing train. Its seven, full dimensioned cars are constructed of steel but will be substantially lighter than present standard equipment. The Pacific locomotive was streamlined in the railroad's shops at West Albany, N. Y.,

(*Turn to next left-hand page*)

and the cars have been under construction in the Big Four shops at Beech Grove, Ind.

Everything in The Mercury, including fabrics, furniture, china, and glassware, has been designed especially for it. The train will be entirely free from uncontrolled slack, thus doing away with jolts in starting and stopping.

The cars will consist of a combination baggage car and coach, a coach with smoking room for men and women, a full length diner with new seating arrangement, a pantry-kitchen car, a lounge bar car, a parlor car and parlor-observation car with streamline rounded rear end, into which is built an electric sign bearing the train's name.

The Mercury's locomotive, which, like the cars, will be painted a dark gray with silver striping, will have roller bearings on its truck, trailer and tender axles. These will be used also on the axles of each car. A feature of the locomotive will be the permanent illumination of its 79-in. disc driving wheels and their silvered rods by floodlights concealed beneath the streamline covering.

A Million Miles of "Zephyrs" on the C. B. & Q.

ONE million miles of Diesel-powered "Zephyr" service on the Chicago, Burlington & Quincy were completed on May 27, and the achievement was celebrated at a luncheon of the Chicago Association of Commerce on that day. The actual millionth mile was run by one of the "Twin Zephyrs" operating between Chicago and the Twin Cities near Savanna, Ill., at 12:55 p.m., while the luncheon was in session at Chicago. Through a National Broadcasting Company radio hook-up the sound of the train as it set off torpedoes and ran through a 21-ft. hoop of paper were transmitted to the luncheon gathering at Chicago. Speakers at the luncheon were H. L. Hamilton, president of the Electro Motive Corporation; Edward G. Budd, president of the Edward G. Budd Manufacturing Company; Ralph Budd, president of the Burlington, and Charles F. Kettering, president of General Motors Research Corporation. The celebration was climaxed by a motion picture showing the train passing through the hoop of paper at Savanna.

Green Diamond on Good-Will Tour

THE Green Diamond, streamline train of the Illinois Central, following a goodwill trip through the southwest, the Mississippi Valley and the great lakes region, and a series of test runs between Chicago and St. Louis, was placed in regular service between these cities on May 17.

During this 7,000-mile good will tour approximately 2,000 persons an hour passed through the train at every stop.

Report of Mechanical Advisory Committee

THE Mechanical Advisory Committee, appointed by the Federal Coordinator for the purpose of co-operating with his Section of Transportation Service, has recently completed a report of seven typewritten volumes covering practically every important phase of the modernization of railway equipment. The interest in and value of this report is such that the General Committee of the Mechanical Division is considering the advisability of printing and distributing it in a single volume of 850 to 1,000 pages, at a cost of $8.00 to $10 a copy, depending upon the number printed.

Both the present and the future requirements of mechanical equipment and motive power designed to meet the needs of railroad shippers and travelers are considered in this report which covers the following general subjects: Steam locomotives; oil-electric locomotives; electric locomotives and electrification of railroads; freight cars; reduction of tare weight; evaluation of light weight; development of passenger car design; materials and methods of construction; rail-motor cars; and container cars.

According to a circular letter recently issued by the secretary of the Mechanical Division, this report will be available to members at the cost of printing, and to non-members at twice this price. Those who desire copies are requested to advise the secretary, V. R. Hawthorne, 59 East Van Buren street, Chicago.

Experimental Construction of Tank Cars Authorized

UPON reconsideration the Interstate Commerce Commission has granted authority which it had previously denied to the Union Tank Car Company to construct for experimental service 15 tank-car tanks fabricated by the fusion welding process and to use in experimental service 10 tanks already constructed. Similar authority was granted to E. I. duPont deNemours & Co., for the construction of one tank of nitric acid resistant metal by the fusion welding process and to the Phillips Petroleum Company to construct 25 tanks by the fusion welding process.

National Machine Tool Builders Association Honored

THE National Machine Tool Builders Association has been presented the American Trade Association Executives Award for the outstanding achievement by a trade association during the past three years. The presentation was made by Secretary of Commerce Roper to Herman H. Lind, general manager of the National Machine Tool Builders Association, at a recent

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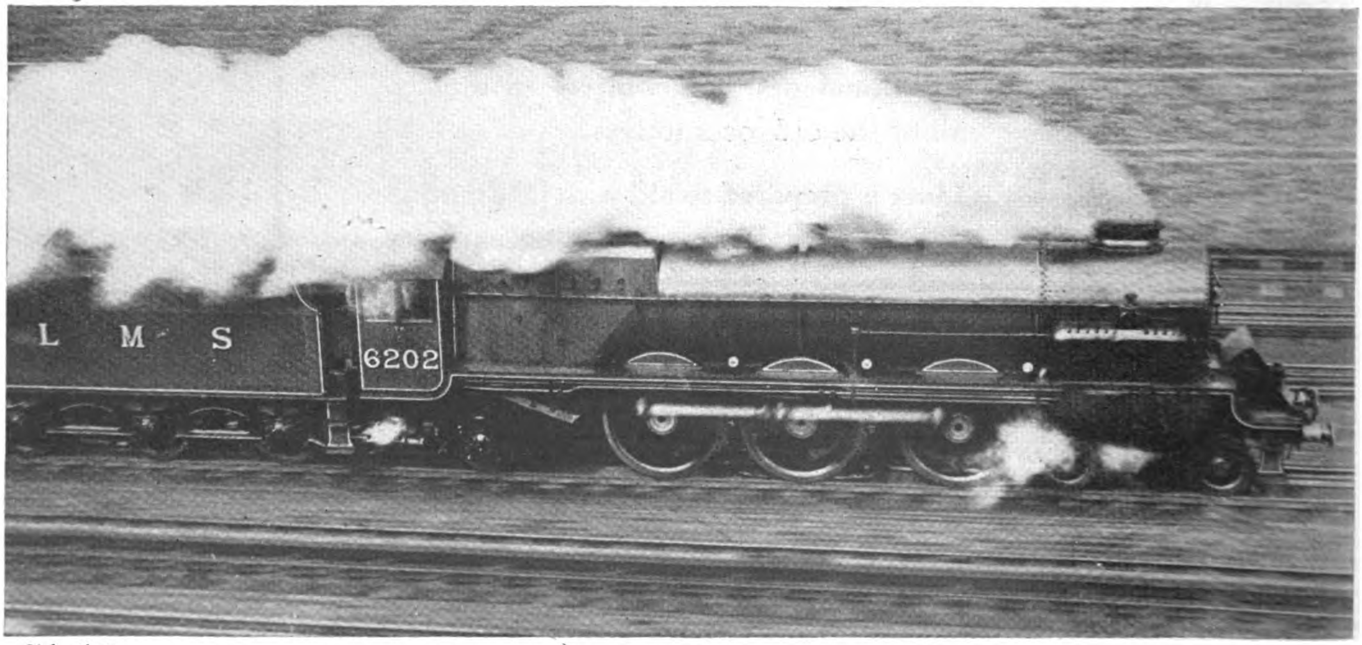
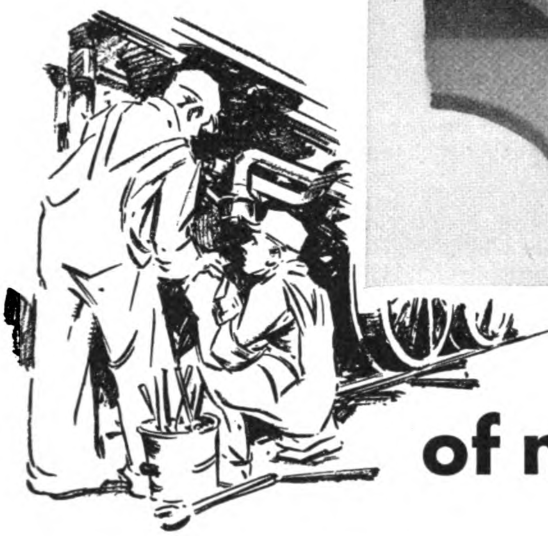
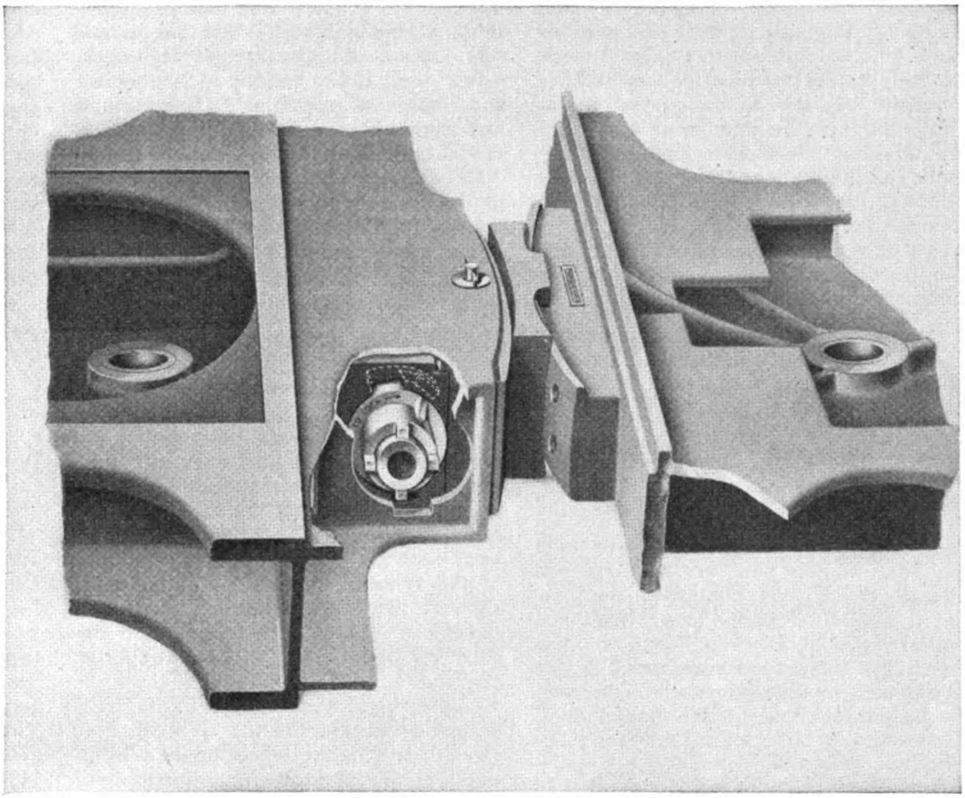


Globe photo

The London, Midland & Scottish turbine locomotive hauling the "Royal Scot" over Bushey water troughs on her way north—For a description of this locomotive see the February *Railway Mechanical Engineer*, page 53

A SAVER





RADIAL BUFFER TYPE E-2

# of maintenance money

Radial Buffer Type E-2 principles are correct.

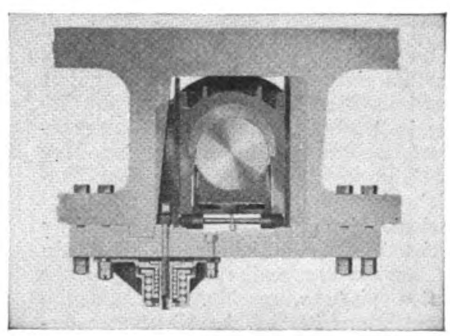
One buffing surface is part of a cylinder—the other, part of a sphere.

The centers of both are where they should be—at the drawbar pins.

Radial Buffer Type E-2 provides positive cushioned contact between engine and tender. It precludes all possibility of slack that causes destructive shocks on drawbar and pins. It guarantees freedom of motion in any direction, yet dampens oscillation between engine and tender.

Its twin, the Franklin Automatic Compensator and Snubber, maintains constant and perfect driving box adjustment.

Both devices improve locomotive operation and greatly reduce locomotive maintenance.



FRANKLIN AUTOMATIC COMPENSATOR AND SNUBBER

All replacement parts furnished by Franklin Railway Supply Company are identical as to materials, design, clearances and workmanship with the parts they replace. They guarantee the same unfailing reliability of service.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

dinner in Washington. The award, it was stated by Secretary Roper, was won because of the Association's helpful work not only to the machine tool and related industries but also to the general public, chiefly through the courageous staging of the Machine Tool Show in Cleveland, Ohio, last Fall. Seven other prizes—honorable recognition certificates — were awarded to other associations, among which were the American Institute of Steel Construction and the Automobile Manufacturers Association.

"Abraham Lincoln" on Faster Schedule

THE Alton has placed its "Abraham Lincoln" on a schedule of 4 hrs. 55 min. between Chicago and St. Louis, thereby meeting the time of the Illinois Central's "Green Diamond," placed in service on May 17. The Abraham Lincoln will leave St. Louis at 8:55 a.m. and will arrive in Chicago at 1:53 p.m. Returning the same day it will leave Chicago at 4:30 p.m. and will arrive in St. Louis at 9:25 p.m. Since April 27 this train has been hauled by the Diesel electric locomotive heretofore used on the Royal Blue of the Baltimore & Ohio.

New Seaboard Diesel Cars

THE Seaboard Air Line has recently placed in service two new streamline Diesel-electric power cars of all-welded, alloy-steel construction, built by the St. Louis Car Company and equipped with 660-hp. Electro-Motive Corporation engines. These power units, which are hauling four-car trains between Rutherfordton, N. C., Charlotte, Monroe, and Hamlet, and between Wilmington, N. C., and Hamlet, are divided into three compartments, the first housing the engine, and the second and third devoted to mail and baggage, respectively. They are 72 ft. long and 13 ft. 2¼ in. high, while the 660 hp. engines are of the eight cylinder, two cycle type.

S. M. Vauclain Honored by Newcomen Society

THE tables were neatly turned on Samuel M. Vauclain, chairman of the board of the Baldwin Locomotive Works, at a luncheon given by him to members of the American Branch of the Newcomen Society in the Junior Room of the Bellevue-Stratford, Philadelphia, on Tuesday, May 19. The guests learned that Mr. Vauclain's eightieth birthday was on the day previous, May 18. George B. Cortelyou feliciated Mr. Vauclain upon his birthday anniversary and enlarged upon the citation made when Mr. Vauclain was elected a member of the Newcomen Society.

Following Mr. Cortelyou, William Carter Dickerman, president of the American Locomotive Company, on behalf of the Newcomen Society, presented Mr. Vauclain with a beautiful silver loving cup, engraved on one side with the name of the Newcomen Society and its emblem, and on the other with these words: "Samuel M. Vauclain, great engineer, able administrator, good citizen." In responding, Mr. Vauclain, in a happy way, outlined something of the philosophy that has carried him so successfully through his eighty years, paid a fine tribute to his mother and emphasized the value of her example and teachings in the meeting of emergencies. That he followed her teachings faithfully was indicated by the intimate recital of some of his experiences in locomotive building and industrial activities.

Labor-Management Pact on Dismissal Allowances

A FIVE-YEAR agreement covering allowances to employees affected by railroad co-ordination or consolidation projects, including two or more carriers, was announced by committees representing the railroads and the railroad labor organizations following a recent conference with the President. The agreement, reached after several months of negotiations, does away with the occasion for the enactment of the Wheeler-Crosser bill, and specifically provides that it shall not apply to changes in volume or character of employment brought about solely by other causes.

Under the agreement, each carrier contemplating a co-ordination is required to give 90 days' notice to employees affected and provision is made for adjustment of any disputes. Three provisions for financial allowances to employees are made—one providing for payment of the difference in compensation for five years for those placed in lower positions; one for payment of 60 per cent wages to employees displaced for varying periods depending on length of service, and another alternate for a lump sum separation allowance. The agreement also provides for reimbursement for expenses and losses suffered by employees required to change place of residence.

No co-ordination is to be made between carriers parties to the agreement and others not participating unless on the basis of an agreement approved by all parties to the agreement.

Demand for "Firemen" on Diesels Met by New England Roads

THE New York, New Haven & Hartford, the Boston & Maine and the Maine Central have agreed to use a "fireman-helper" on each of their present Diesel locomotives, including streamline trains, thereby settling the issue which had threatened to result in a strike of members of the Brotherhood of Locomotive Firemen & Enginemen.

In announcing its agreement the New Haven said that it has "agreed to use a fireman on present Diesel power includ-

New Equipment

		LOCOMOTIVE ORDERS	
Road	No. of locos.	Type of locomotive	Builder
Alton & Southern	1	2-8-2	Baldwin Loco. Works
N. Y., N. H. & H.	10[1]	4-6-4	Baldwin Loco. Works
		LOCOMOTIVE INQUIRIES	
Southern Pacific	12	4-8-8-2	....
	6	4-8-4	....
		FREIGHT-CAR ORDERS	
Road	No. of cars	Type of car	Builder
Chesapeake & Ohio	1,700	50-ton hopper	Pullman-Std. Car Mfg. Co.
	1,800	50-ton hopper	American Car & Fdry. Co.
	500	50-ton gondola	Bethlehem Steel Co.
	150	Gondola	Bethlehem Steel Co.
	100	50-ton gondola	Ralston Steel Car Co.
	500	50-ton box	Pullman-Std. Car Mfg. Co.
	150	Auto-box	Pullman-Std. Car Mfg. Co.
	500	Box	General Amer. Trans. Corp.
Chicago & North Western	18	Steel underframes for 50-ton auto. box	American Car & Fdry. Co.
Missouri Pacific	1,500	50-ton box	Mt. Vernon Car Mfg. Co.
	500	50-ton hoppers	American Car & Fdry. Co.
N. Y., C. & St. L.	500	50-ton box	General American
	200	50-ton gondola	Bethlehem Steel Co.
	50	50-ton flat	Bethlehem Steel Co.
	25	70-ton gondola	Bethlehem Steel Co.
	2	100-ton flat	American Car & Fdry. Co.
Norfolk & Western	500	57½-ton hopper	Pressed Steel Car Co.
	500	57½-ton hopper	Virginia Bridge Co.
Pere Marquette	100	50-ton auto. furniture	Ralston Steel Car Co.
	400	40-ton auto.	Ralston Steel Car Co.
		FREIGHT-CAR INQUIRERS	
American Refrig. Transit Co.	1,000	40-ton refrig.	....
Southern Pacific	1,750	Box	....
	750	Auto.	....
	200	Flat	....
	100	Gondolas	....
		PASSENGER-CAR ORDERS	
Chicago, Rock Island & Pac.	4[2]	Buffet-bagg.	American Car & Fdry. Co.
		PASSENGER-CAR INQUIRIES	
Southern Pacific	20	80-ft. bagg.-horse	....
Temiskaming & No. Ontario.	5	Coaches	....

[1] These locomotives, the purchase of which has been authorized by the trustees of the New Haven, will be streamline, roller-bearing steam locomotives of the 4-6-4 type, for fast passenger service between New Haven, Conn., and Boston, Mass. They will have a starting tractive effort of 44,100 lb., which is 6,350 lb. greater than the present locomotives used in the Shore Line service. Engine and tender together will weigh approximately 350 tons. The total weight of engine alone will be 180 tons, with 195,000 lb. on the drivers. The tenders will have water tanks of 20,000 gal. capacity and will hold 16 tons of coal. The overall length of the new locomotives, including tender, will be 101 ft. 9¾ in., and they will have a wheel base of 88 ft. 3 in. The locomotives will have one-piece cast-steel frames with integral cylinders. The 80-in. driving wheels will be cross-counterbalanced. High-tensile nickel steel is to be used in the construction of the boilers because of the unusually high steam pressure of 285 lb. The new engines are designed for the hauling of 15-car passenger trains at high speeds, and are expected to produce substantial operating economies. Delivery is expected some time in the fall.

[2] For conversion and modernization.

ing the 'Comet.' The matter of having a fireman on Diesel switching locomotives which may be placed in service at a later date was left open for future discussion on a regional or national basis."

The Boston & Maine has agreed to employ firemen as helpers in the cab of the streamline "Flying Yankee," in the cabs of its two Diesel-propelled passenger locomotives, and in the cabs of its two Diesel switching engines, it was announced by J. W. Smith, vice-president and general manager. The road agreed last February to place firemen as helpers on its streamline train and on its Diesel locomotives in passenger service, but declined to agree as regards future Diesel units. The agreement signed May 26 contains a proviso that the "management agrees to become a party to a regional or national concerted movement if and when inaugurated by the Brotherhood of Locomotive Firemen & Enginemen for the purpose of securing firemen as helpers on that type of power in switching service."

Officers of the Maine Central railroad stated that that road had signed an agreement with the B. of L. F. & E. similar to that signed by the Boston & Maine. It affects only the streamline "Flying Yankee"and a Diesel power unit operating between Bangor, Me., and Vanceboro on Maine Central lines.

Supply Trade Notes

The National Machine Tool Builders Association has removed its offices to 10525 Carnegie avenue, Cleveland, Ohio.

The Republic Steel Corporation has opened a sub New York district sales office in the State Bank building, Albany, N. Y., with J. M. Higinbotham, salesman in charge.

Herbert W. Snyder, mechanical engineer of the Lima Locomotive Works, Inc., Lima, Ohio, has been appointed also works manager.

C. E. Murphy has been appointed sales representative of the Fansteel Metallurgical Corporation, North Chicago, Ill., with headquarters at 415 Midland Building, Cleveland, Ohio.

H. E. Mensch has been appointed district sales agent for the Michigan territory of the Ohio Locomotive Crane Company, Bucyrus, Ohio. Mr. Mensch is located at 424 Book building, Detroit, Mich.

M. W. Smith, who has been in charge of the design of large rotating alternating current machinery of the generator division of the Westinghouse Electric & Manufacturing Company, has been appointed manager of engineering.

The American Steel Foundries has moved its New York office from 30 Church street to the New York Central building, 230 Park avenue. A new branch sales office has been opened in the Baltimore Trust building, Baltimore, Md., in charge of Charles B. Peirce, Jr.

James E. Nolan has been appointed purchasing agent of the Scullin Steel Company, St. Louis, Mo.; Harry C. Dreibuss has been appointed chief mechanical engineer and James Glover and R. C. Geekie have joined the sales department, all with headquarters at St. Louis.

Standard Stoker Company, Inc., following the death of W. C. Peyton, has elected the following officers: H. H. Wehrhane, president; R. E. Coulson, vice-president; F. P. Roesch, vice-president; E. A. Turner, vice-president; W. D. Gray, secretary; B. Peyton, treasurer.

The Young Radiator Company, Racine, Wis., has appointed the C. H. Bull Company, 115 Tenth street, San Francisco, Calif., to handle the sale of Young heavy duty radiators, oil coolers, heat exchangers and air-conditioning equipment on the west coast.

Russell D. John has been appointed eastern sales manager, with headquarters at 50 Church street, New York, of The Adams & Westlake Company, Elkhart, Ind., and E. H. Leisch has been appointed district sales manager, with headquarters at Chicago.

E. J. Richey has been appointed sales representative of the Garlock Packing Company, New York, succeeding the late M. M. Llera. Mr. Richey was for a number of years with the Pennsylvania Railroad and the Worthington Pump & Machinery Corporation.

The Chicago Pneumatic Tool Company has opened a new sales and service branch at 2415 Commerce street, Dallas, Texas, in charge of D. G. Reeder, district manager. The Pittsburgh, Pa., office of the company is now at 810 Chamber of Commerce building, Pittsburgh.

Joseph M. Brown, railway representative of the bus and truck division of the White Motor Company, with headquarters at Chicago, and previously connected with the Elwell-Parker Electric Company, has been appointed special railway representative of the National Twist Drill & Tool Company, Detroit, Mich., with headquarters in Chicago.

C. R. Cox, general superintendent of Ellwood works of the National Tube Company, has been elected vice-president in charge of engineering and operations, with headquarters at Pittsburgh, Pa., succeeding P. C. Patterson, who was associated with the Tube Company for 49 years and who had been, since 1926, vice-president in charge of engineering and operations.

A. E. Walker, general sales manager of the Republic Steel Corporation, Cleveland, Ohio, has been elected president of the Truscon Steel Company to succeed Julius Kahn, who has been elected a vice-president of the Republic Steel Corporation in charge of production developments. Mr. Walker will continue as the sales manager of the Republic Steel Corporation.

Thomas Prosser & Son, New York, has discontinued the sale of Widia blanks, tools and parts thereof, the importation of Widia cutting tool material into the United States having been discontinued by the Fried. Krupp Works, Essen, Germany. The entire cemented carbide tool business of Prosser & Son, including its inventory of Widia metal, has been turned over to the Carboloy Company, Inc., Detroit.

James C. Travilla, of the mechanical department of the General Steel Castings Corporation, with headquarters at Granite City, Ill., has been appointed mechanical engineer in charge of the section of the mechanical department at the Commonwealth plant in that city, to succeed W. O. Ashe, who has been appointed sales engineer in the western district sales department at Granite City.

J. W. Braffett, for the past seven years Detroit, Mich., representative of the Oliver Iron & Steel Corp., has joined the Detroit sales staff of the Republic Steel Corporation, Upson Nut division, with headquarters in the Fisher building; L. L. Caskey has been appointed district sales manager for the Republic Steel Corporation in the Philadelphia, Pa., territory, succeeding J. B. DeWolfe, who has been transferred to the general offices at Cleveland, Ohio, to assist George E. Totten, manager of sales of the Tin Plate division.

The Lincoln Electric Company, Cleveland, Ohio, has made changes and promotions in its sales personnel as follows: J. S. McKeighan has been transferred to the sales staff with office at 1712 Catalpa drive, Dayton, Ohio, operating under the Cincinnati district office; J. B. McCormick has been transferred from the Philadelphia, Pa., office to the Pacific coast, with office at Monticello avenue, Fresno, Cal., under the personnel of the Los Angeles office; Paul W. James has been transferred from the factory to 16½ Crandall street, Binghamton, N. Y., operating under the Syracuse office. The Major Engineering Works has moved its offices from 210 Jackson avenue to 312 Second street, Des Moines, Iowa.

Charles R. Robinson, first vice-president and general manager of sales and a director of the Inland Steel Company, Chicago, has resigned. Mr. Robinson started his business career in 1890 as a salesman of tool steel for Park Brothers & Co. In 1900 he entered business for himself, handling various steel products on a brokerage basis. In 1904, he entered the employ of the Inland Steel Company as a salesman, becoming assistant general manager of sales in 1906. In October, 1908, he resigned from the Inland Steel Company to become district sales manager for the Lackawanna Steel Company at Chicago, and in 1910 was transferred to New York as general manager of sales. In the following year his headquarters were transferred to Buffalo, N. Y. He held the

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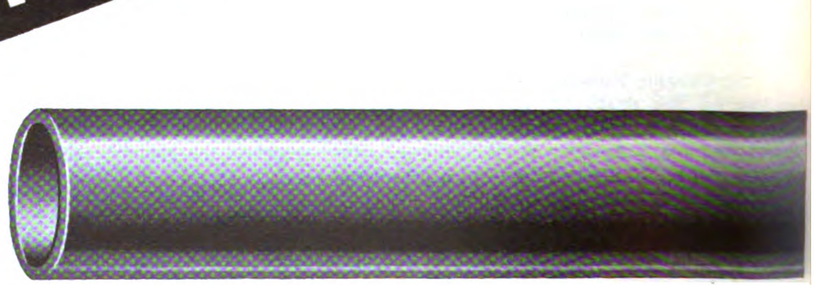

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An outstanding contribution to the improvement of boiler tubes made possible by the latest-type controlled atmosphere bright annealing furnace.

Not so many years ago, Steel and Tubes, Inc., announced a new and modern type of boiler tube —ELECTRUNITE—possessing many features not attained commercially in any other type of tube. That industry quickly realized the advantages of this tube is attested by the thousands and thousands of tubes installed and giving safe, trouble-free, economical service today.

During this time, many further improvements have been made in ELECTRUNITE Boiler Tubes. Steel and Tubes engineers, not satisfied even with the best, are continually seeking new processes or new methods that will provide industry with even better tubes.

Now, Steel and Tubes announces a new development—an outstanding contribution to the improvement of boiler tubes—a tube normalized at a temperature above 1650° F. without producing scale or in any way disturbing the fine surface of the original cold-worked tubing.

Pickled flat-rolled steel, absolutely scale-free and with a surface further improved by cold working during the forming of the tube, is passed through the latest type controlled atmosphere electric bright annealing furnace. Because the furnace temperature is accurately controlled, there is never any danger, regardless of how heavy the gauge, of crystallization of the metal, and thus accurate control of grain size is insured.

The resulting tube is entirely free from scale, inside and outside. The bright surface resulting is an aid to inspection, as defects cannot be concealed—thus making ELECTRUNITE Boiler Tubes the safest tubes that can be installed. Add the advantage of the controlled atmosphere normalizing to these features—uniformity of diameter; uniformity of wall thickness rarely varying more than .003 in. at any cross-section; a weld as strong as the wall; freedom from inside scabs, slivers, seams, etc.—and the real value of this improved ELECTRUNITE Boiler Tube is quickly apparent.

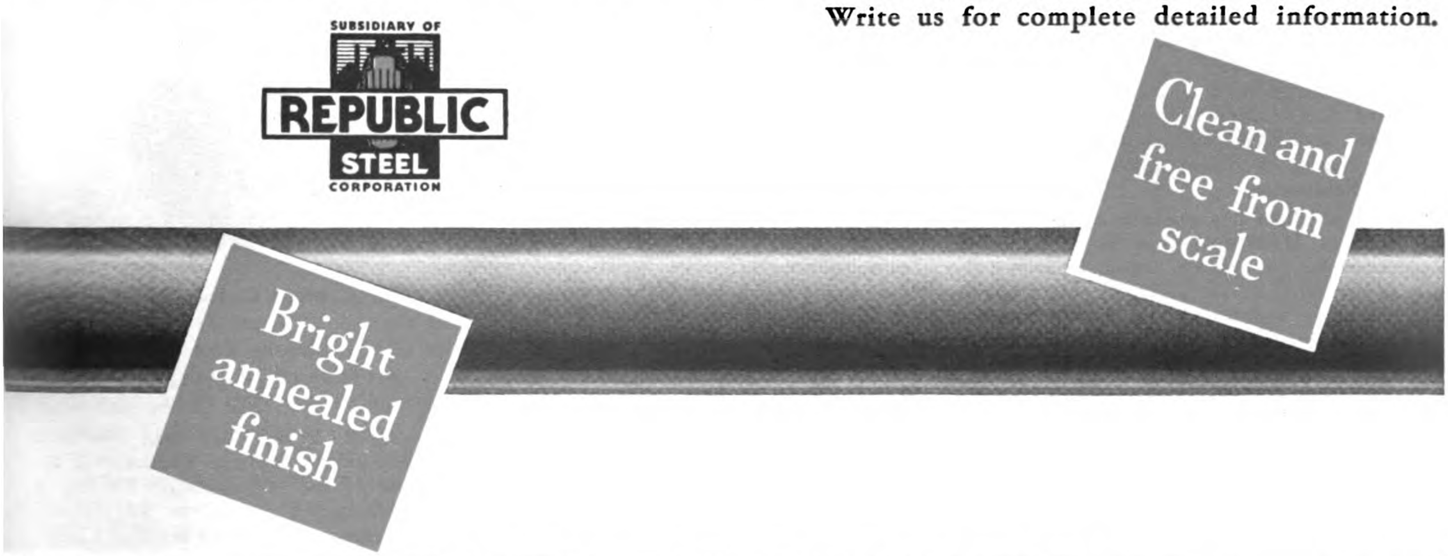
Would like to know more about ELECTRUNITE? Write us for complete detailed information.

Steel and Tubes *Inc.*

WORLD'S LARGEST PRODUCER OF ELECTRICALLY WELDED TUBING

CLEVELAND . . . OHIO

SUBSIDIARY OF REPUBLIC STEEL CORPORATION



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latter position until 1918, when he was elected vice-president in charge of sales. In January, 1922, he returned to the Inland Steel Company, coincident with that company's entrance into the rolling of standard section heavy T-rails, becoming vice-president in charge of railroad sales. In August, 1935, he was elected first vice-president and general manager of sales.

H. W. JOHNSON has been appointed manager of sales of the Railway Specialty department of the Lewis Bolt & Nut Company, Minneapolis, Minn. Mr. Johnson was born at Marshalltown, Iowa, on November 25, 1884. After studying mechanical engineering at Iowa State University, he entered the employ of the Minneapolis & St. Louis as machinist apprentice on

H. W. Johnson

June 1, 1902. On February 1, 1908, he became car and enginehouse foreman at Peoria, Ill.; in 1915 was appointed general foreman at Marshalltown, Iowa; in 1922 was promoted to the position of master car builder, and on August 15, 1923, became superintendent of motive power and rolling stock. Since March 1, 1935, he had been traffic representative of the Minneapolis & St. Louis.

J. G. BLUNT, mechanical engineer of the American Locomotive Company, has been appointed chief mechanical engineer, with headquarters at Schenectady, N. Y.; A. W. Bruce, designing engineer, has been appointed assistant vice-president, locomotive engineering, with headquarters at New York; E. J. Edwards, engineer of tests, has been appointed chief metallurgical engineer, with headquarters at Schenectady, and A. I. Lipetz, consulting engineer, has been appointed chief consulting engineer, in charge of research, with headquarters at Schenectady.

J. G. Blunt is a graduate of the University of Michigan, where he obtained his Bachelor of Science degree in 1894. In 1897, after a few years' experience as a machinist and draftsman with several manufacturing concerns, Mr. Blunt became a draftsman in the employ of the Brooks Locomotive Company at Dunkirk, N. Y. In 1899 he was promoted to the position of foreman and later became chief draftsman. In 1906, when the general drawing room of the American Locomotive Company was formed by moving all the subsidiary plant engineering forces to Schenectady, Mr. Blunt, under the title of engineer of the drafting department, was assigned the duties of organizing these combined forces at Schenectady. Following this he was appointed superintendent of the general drawing room, and in 1916 became mechanical engineer.

A. W. Bruce is a graduate of the Worcester Polytechnic Institute (1901). From 1901 to 1903 he was employed in the drawing room of the Rhode Island Works of the American Locomotive Company and in 1904 was transferred to the calculating department of the Schenectady Works. In 1905 he accepted a position in the mechanical engineer's office of the Northern Pacific at St. Paul, Minn., and during 1906 and 1907 was with the American Car and Foundry Company at New York and Berwick, Pa. In 1908 Mr. Bruce returned to the engineering department of the American Locomotive Company at New York and was later given full charge of the specification department. In 1924 he was appointed designing engineer.

E. J. Edwards entered the employ of the American Locomotive Company as an office boy in 1906. In 1907 he was transferred to the laboratory at Schenectady, and later served successively as local engineer of tests at the Cooke and Rogers plants; in charge of heat-treating activities at various plants; laboratory foreman, and assistant engineer of tests. In April, 1917, he was appointed engineer of tests. Mr. Edwards is an active member of the American Foundrymen's Association, the American Metals Society, the American Welding Society, and the American Society for Testing Materials. Recently he was appointed chairman of a group representing the American Society for Testing Materials to co-operate with the Materials Section of the Boiler Construction Code of the American Society of Mechanical Engineers.

A. I. Lipetz, upon graduation in Russia in 1902 with the degree of engineer technologist (mechanical engineer), entered railway service as an apprentice on the Moscow-Kiev-Voronesh Railway, later serving as draftsman, engineer, inspector and assistant master mechanic. From 1906 to 1909 he was assistant professor of thermodynamics and railway mechanical engineering at the Kiev Polytechnic Institute, Kiev, Russia, passing there examinations preliminary to the degree of Adjoint of Applied Mechanics (Doctor of Engineering). For the following three years he held the positions of senior motive power inspector and chief of the locomotive department of the Taskent Railway, and from 1913 to 1917 served in the Russian Railway Administration, Ministry of Transportation, Petrograd, Russia, as chief of the locomotive department. During this period he was sent twice by the Russian Imperial Government to the U. S. A. He served the Russian State Railways in the United States, first as representative of the Railway Administration and later as assistant chief and then chief of the Russian Mission of Ways of Communication. In 1920 Mr. Lipetz joined the American Locomotive Company as European sales and technical representative, in 1925 becoming consulting engineer at Schenectady. He is the author of books and many papers on steam and Diesel locomotives and in 1930 was the reporter for America on locomotives of new types at the International Railway Congress held at Madrid, Spain. Since 1927 he has been also non-resident professor of locomotive engineering at Purdue University, Lafayette, Ind.

JOSEPH L. BLOCK, vice-president of the Inland Steel Company, Chicago, has been elected executive vice-president in charge of sales to succeed Charles R. Robinson,

Joseph L. Block

resigned, and Albert C. Roeth, vice-president, has been elected vice-president and general manager of sales. Mr. Block has been associated with the Inland Steel Company since 1922. He has been a vice-president since 1929 and a director since 1930. For a number of years he has been in charge of the sale of bars and semi-finished steel, and has also directed the company's advertising activities.

Mr. Roeth has been associated with Inland since 1911, and has been a vice-president

Albert C. Roeth

dent of the company since 1929. He has been in charge of the sale of structural shapes, plates and sheet piling.

FRANK B. POWERS has been appointed manager of the Railway Engineering department of the Westinghouse Electric & Manufacturing Company, to fill the vacancy caused by the recent death of Claude

Bethel. Mr. Powers was born at Chicago, and following his graduation with the degree of B. S. in E. E. from the University of Illinois, he joined the Westinghouse Electric & Manufacturing Company, attending both the engineering and the design schools as part of the company's graduate student course. After this training he helped service the 6,000-hp. Virginian Railway locomotives. On his return to Westinghouse at East Pittsburgh, Mr. Powers entered the heavy traction section of the Railway Engineering department, specializing on the design of motors for the Pennsylvania Railroad locomotives. In January, 1935, he was promoted to section engineer of all d.c. traction motors, which position he held until this new appointment.

Obituary

Howard P. Anderson, chief engineer, The Standard Stoker Company, Inc., died on May 2, at his home in Erie, Pa., at the age of 57.

Edward H. Fisher, connected with the sales department of the American Car and Foundry Company for 28 years, died on April 25, in New York hospital, after an illness of over two years.

William A. Lake, sales manager of the Railroad and Marine departments of the Pantasote Company, Inc., New York, died on May 10 after a prolonged illness in New York. Mr. Lake entered the service of the Pantasote Company in April, 1909,

William A. Lake

in its sales department, and in May, 1924, was given charge of the railroad and marine fields for the disposition of all Pantasote and Agasote products. Mr. Lake was for years an active member of various railway clubs.

William O. Jacquette, formerly eastern sales manager of the Pullman Company, at New York, from which position he retired about 1925, died suddenly on the links of the Englewood (N. J.) Golf Club on May 8.

Claude Bethel, manager of the Railway Engineering department of the Westinghouse Electric & Manufacturing Company and a contributor to many important developments in the electric transportation industry, died recently after a week's illness of pneumonia.

William Blair Keys, who had been associated with the Baldwin Locomotive Works since 1911, died suddenly in Philadelphia, Pa., on April 30. Mr. Keys was born at Gordonsville, Va., on December 13, 1873. He was a graduate of Miller School

W. B. Keys

(1890). In 1892 he entered the service of the Chesapeake & Ohio as a telegraph operator; in 1896, went into the offices of the Norfolk Southern, and from 1904 to 1906 served as assistant to the general superintendent at Norfolk, Va. He was then for a short time associated with the Atlantic Coast Line. He entered the employ of the Baldwin Locomotive Works in 1911 and later became manager of the Richmond office, in which position he served for a number of years. Upon the discontinuance of the Richmond office in 1931 Mr. Keys established headquarters at the main sales office in Philadelphia, from whence he continued to serve the Southern territory until his death.

J. O. Brumbaugh, representative of the Gold Car Heating & Lighting Company, Brooklyn, N. Y., died after a prolonged illness at his home in South Ozone Park, N. Y., on April 30, at the age of 70. Mr. Brumbaugh had been with this company for over 35 years.

Burton L. Delack, general assistant to Vice-President W. R. Burrows of the General Electric Company and until two years ago manager of the company's Schenectady works, died on May 7, following a stroke suffered at his office the previous afternoon.

Personal Mention

General

E. L. Grimm, assistant to the operating vice-president of the Northern Pacific, with headquarters at St. Paul, Minn., has assumed the duties of Silas D. Zwight, general mechanical superintendent, who retired on June 1.

C. E. Melker, master mechanic of the Chicago, Burlington & Quincy at Hannibal, Mo., has been appointed superintendent of motive power, with headquarters at Havelock, Neb., to succeed H. H. Urbach. Mr. Melker was born on October 19, 1890, at Lincoln, Neb. He entered the

Charles E. Melker

service of the Burlington on May 6, 1907, as a machinist apprentice at Lincoln. Upon the completion of his apprenticeship he became a machinist and on June 15, 1916, was promoted to the position of enginehouse foreman, serving successively at Lincoln, Alliance, Neb., and Greybull, Wyo. On February 14, 1920, he was appointed master mechanic at Casper, Wyo., and on March 16, 1930, was transferred to Hannibal, Mo.

Silas D. Zwight, general mechanical superintendent of the Northern Pacific at St. Paul, Minn., has retired after 48 years of service on the road. Mr. Zwight was born on May 23, 1867, at La Crosse, Wis.,

Silas D. Zwight

and after a business-college education he entered railway service with the Chicago, Burlington & Quincy in May, 1886, with which company he served in various capacities. In June, 1888, Mr. Zwight left the Burlington to go with the Northern Pacific as a locomotive fireman on the Dakota division. Subsequently he served successively as a locomotive engineer, road foreman of engines, master mechanic, gen-

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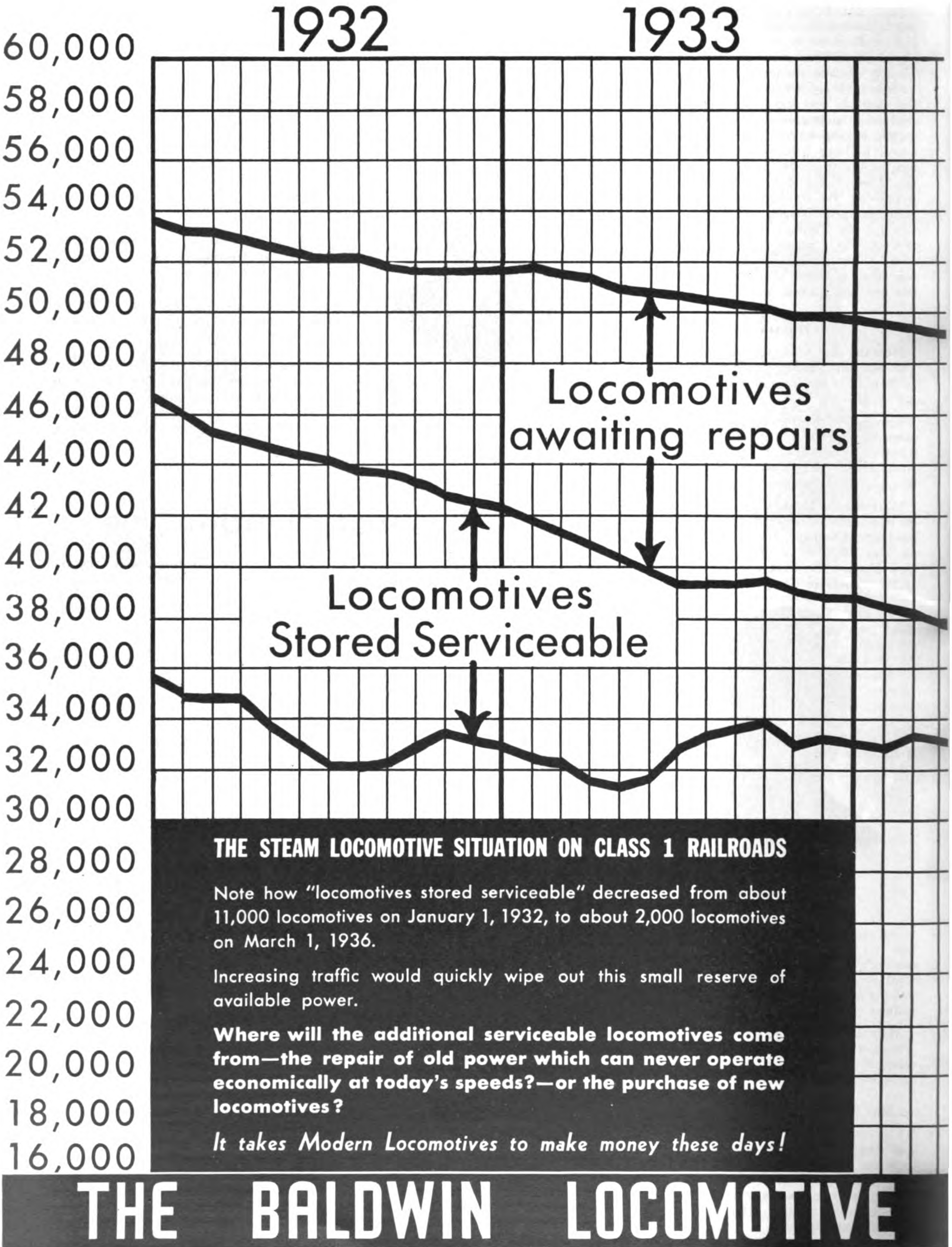
1932
1933
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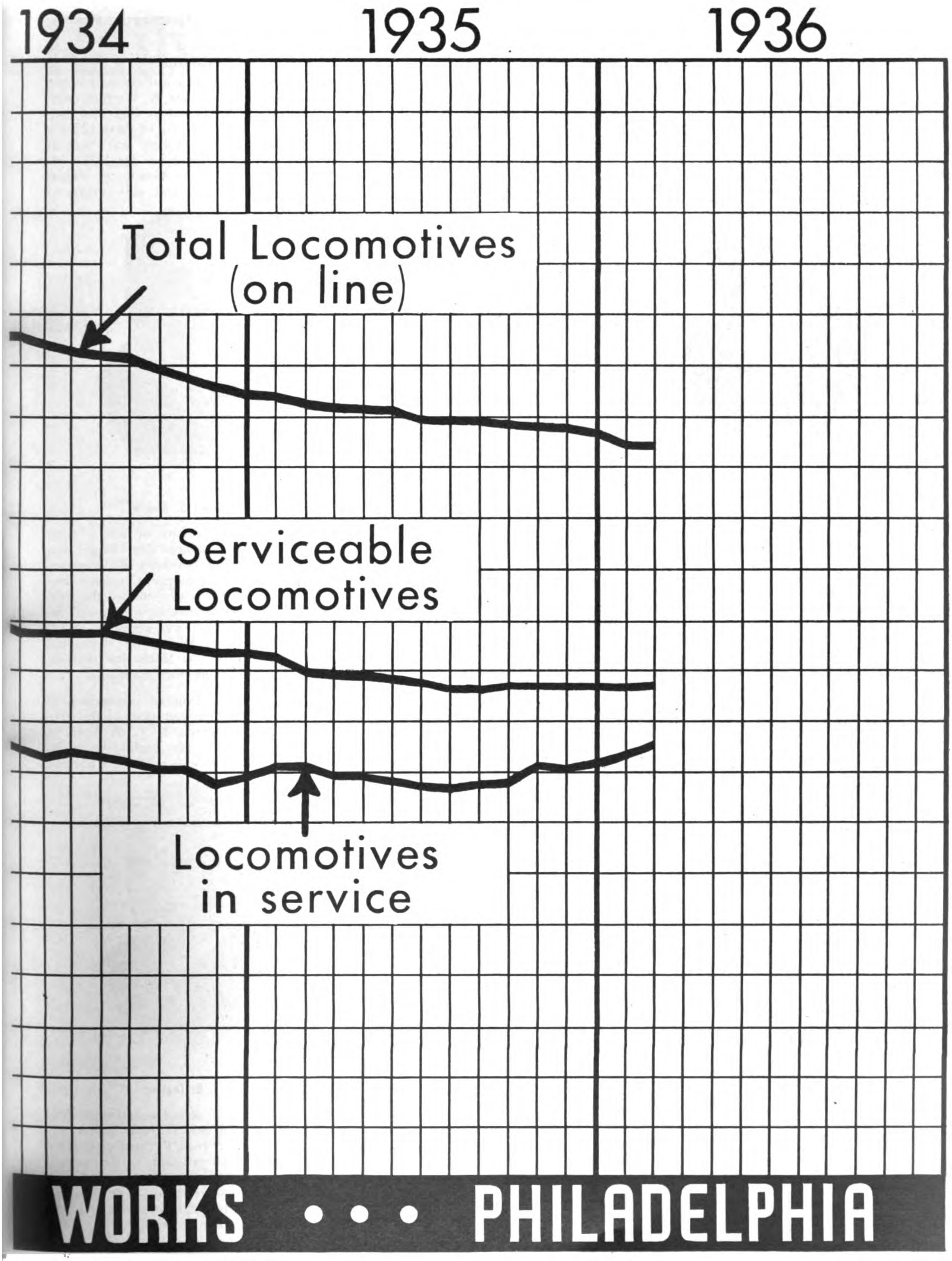
32,000
30,000
28,000
26,000
24,000
22,000
20,000
18,000
16,000
Locomotives awaiting repairs
Locomotives Stored Serviceable
THE STEAM LOCOMOTIVE SITUATION ON CLASS 1 RAILROADS
Note how "locomotives stored serviceable" decreased from about 11,000 locomotives on January 1, 1932, to about 2,000 locomotives on March 1, 1936.
Increasing traffic would quickly wipe out this small reserve of available power.
Where will the additional serviceable locomotives come from—the repair of old power which can never operate economically at today's speeds?—or the purchase of new locomotives?
It takes Modern Locomotives to make money these days!
THE BALDWIN LOCOMOTIVE


1934
1935
1936
Total Locomotives
(on line)
Serviceable
Locomotives
Locomotives
in service
WORKS • • • PHILADELPHIA

eral master mechanic, assistant to the mechanical superintendent, mechanical superintendent and acting general mechanical superintendent. In December, 1923, he was appointed general mechanical superintendent.

J. H. Reisse, mechanical assistant to the executive vice-president of the Chicago, Burlington & Quincy, has retired. Mr.

J. H. Reisse

Reisse was connected with the Burlington for 31 years. He was born on October 14, 1880, and studied mechanical engineering with the International Correspondence Schools. After serving with the Pullman Company from 1899 to 1905, he entered the employ of the Burlington in the latter year as a draftsman at Aurora, Ill., later being transferred to Chicago. In December, 1905, he was appointed leading draftsman; in May, 1918, became chief draftsman and in May, 1925, mechanical inspector. On March 4, 1926, he was appointed mechanical assistant to the vice-president.

H. H. Urbach, superintendent of motive power of the Chicago, Burlington & Quincy, Lines West of the Missouri river, with headquarters at Havelock, Neb., has been appointed to mechanical assistant to

Henry H. Urbach

the executive vice-president, with headquarters at Chicago, succeeding J. H. Reisse, who has retired. Mr. Urbach was born on February 4, 1890, at Sutton, Neb., and entered the service of the Burlington on February 18, 1907, as a machinist apprentice at Havelock, Neb. After finishing the period of apprenticeship he served as a machinist at Havelock until July, 1914, when he was transferred to Alliance, Neb. In the following year he was transferred to Edgemont, S. D., and in April, 1915, he was appointed enginehouse foreman at Seneca, Neb., later being transferred to Alliance. In November, 1917, Mr. Urbach was promoted to the position of general foreman at Edgemont, later serving at Alliance and at Denver, Colo. He then became assistant master mechanic at Galesburg, Ill., and in September, 1923, master mechanic of the Brookfield division at Brookfield, Mo. Late in 1925 Mr. Urbach was transferred to McCook, Neb., and in July, 1926, was appointed assistant superintendent of motive power, Lines East of the Missouri river, with headquarters at Chicago. On March 20, 1927, he became superintendent of motive power, Lines West of the Missouri river, with headquarters at Havelock.

E. H. Roy, assistant general superintendent motive power of the Seaboard Air Line, with headquarters at Savannah, Ga., has been appointed general superintendent motive power, with headquarters at Norfolk, Va., succeeding C. S. Patton, who has retired from active duty after 35 years of continuous service with the Seaboard Air Line.

Master Mechanics and Road Foremen

P. S. Mock, general foreman of the Long Island Railroad, has been appointed acting master mechanic, succeeding H. K. LeSure, transferred.

C. J. Dietrich, general foreman of the Chicago, Burlington & Quincy at Lincoln, Neb., has been appointed master mechanic of the McCook division, with headquarters at McCook, Neb.

E. A. Schrank, master mechanic of the Chicago, Burlington & Quincy at McCook, Neb., has been transferred to the Galesburg-Ottumwa divisions, with headquarters at Galesburg, Ill.

F. R. Butts, master mechanic of the Chicago, Burlington & Quincy at St. Joseph, Ill., has been transferred to the Hannibal division, with headquarters at Hannibal, Mo., to replace C. E. Melker.

Frank X. Jones, road foreman of engines of the eastern district of the Erie, at Jersey City, has been appointed district road foreman and fuel supervisor of the eastern district.

Howard Beattie, assistant district fuel supervisor, Eastern district of the Erie, with headquarters at Jersey City, N. J., has been appointed road foreman of engines, Buffalo division, with headquarters at Buffalo, N. Y.

C. J. Harty, who has been connected with the office of the executive vice-president of the Chicago, Burlington & Quincy at Chicago, has been appointed assistant master mechanic of the Wymore division, with headquarters at Wymore, Neb.

W. L. Castleman has been appointed assistant to the supervisor of internal combustion engines of the Chicago Great Western, with headquarters at Minneapolis, Minn.

Obituary

S. S. Riegel, mechanical engineer of the Delaware, Lackawanna & Western, with headquarters at Scranton, Pa., died suddenly in Buffalo, N. Y., on May 12 of a heart attack. Mr. Riegel was born at Stouts, Pa., on November 14, 1872. He received his early education in the schools of Bethlehem, Pa., and was graduated

Samuel S. Riegel

from Lehigh University in 1897. After graduation from college Mr. Riegel was employed by the Southern Railway and the American Locomotive Company until January 1, 1909, when he entered the service of the Lackawanna as mechanical engineer. Mr. Riegel was active in affairs of the American Society of Mechanical Engineers and of the Mechanical division, Association of American Railroads.

John Ernest Ingling, supervisor of fuel and locomotive operations of the Erie, who died at Paterson, N. J., on April 14, was 62 years old. Mr. Ingling began his career with the Erie in 1897 as a fireman,

J. E. Ingling

and subsequently served as assistant road foreman of engines, assistant master mechanic, engineer, road foreman of engines, trainmaster and assistant to the general manager. He was appointed supervisor of fuel and locomotive operation in 1931, first with headquarters at New York and later at Cleveland, Ohio.

Railway Mechanical Engineer

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic. Name Registered, U. S. Patent Office

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Mechanical Division, A. A. R., Meeting:

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The Reader's Page:

General:

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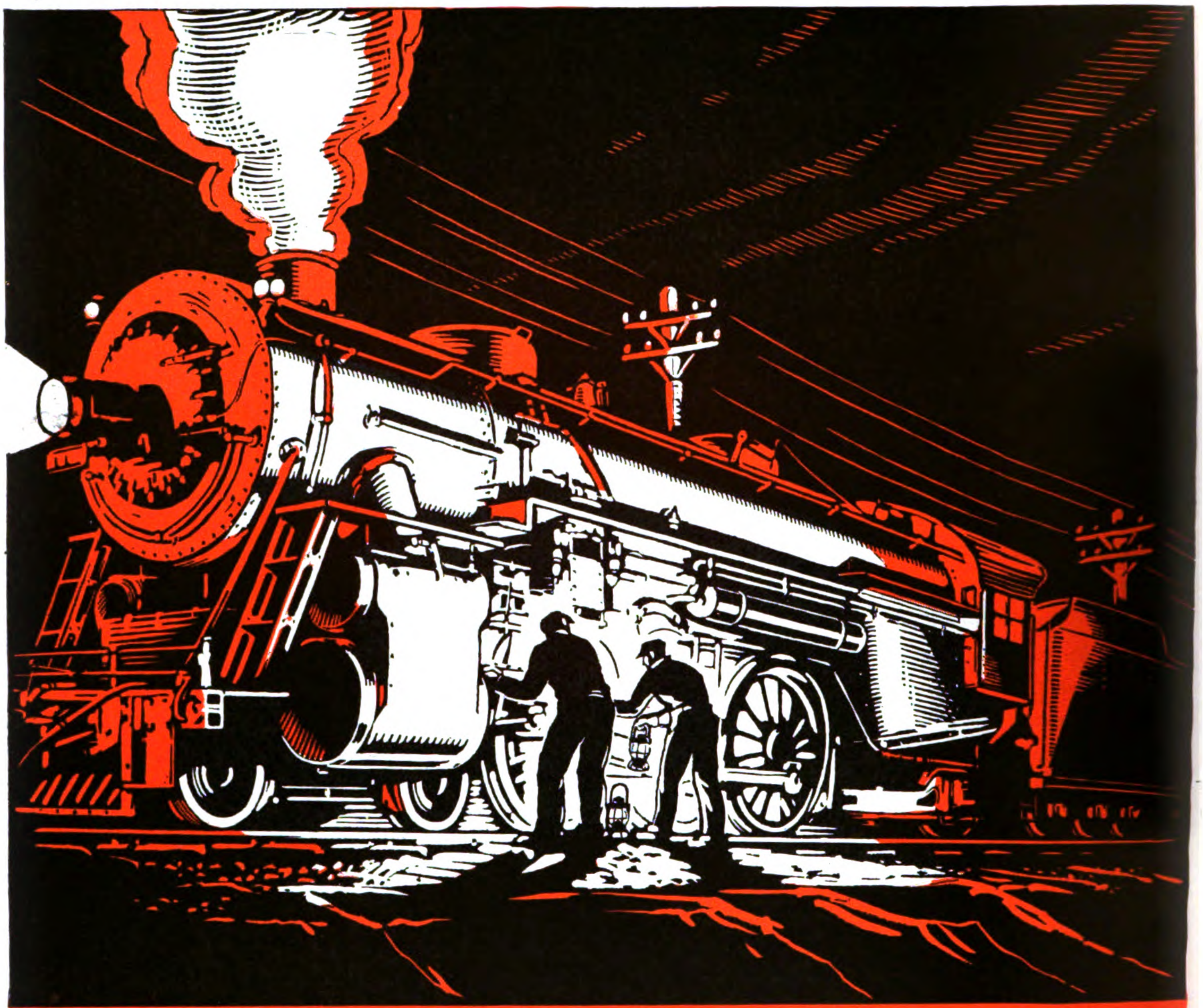

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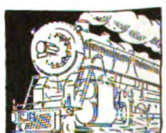
When pins or axles fail don't replace them with others of the same material—only to have them fail again in time. » » » Metallurgists of Republic Steel Corporation have developed alloy forging steels of greater shock resistance, toughness and resistance to fatigue. » » » These Agathon Alloy Steels are specially fitted to meet the increased stresses of higher speed railroading. Write Dept. RG for complete information.

REPUBLIC STEEL

Republic Steel
CORPORATION

ALLOY STEEL DIVISION, MASSILLON, OHIO
GENERAL OFFICES: CLEVELAND, OHIO



LOCOMOTIVE JACKET SHEETS
Among its many railroad specialties Republic makes steel sheets for locomotive jackets. They take a fine polish.

RAILWAY
MECHANICAL ENGINEER

Fifteenth Annual Meeting of the

Mechanical Division, A.A.R.

O. A. Garber,
Chairman

THE fifteenth annual meeting of the Mechanical Division of the Operations and Maintenance Department, Association of American Railroads was held at the Congress Hotel, Chicago, June 25 and 26. O. A. Garber, chief mechanical officer, Missouri Pacific, chairman of the Division, called the meeting to order and, before proceeding with the program called upon the members present to stand a moment in silence out of respect to the memory of W. G. Black, vice-president, Chesapeake & Ohio, whose death, on June 20, deprived the Division of its vice-chairman.

The report of the General Committee was received and approved by a vote of the members present. This report included a review of the events of importance since the last meeting of the Division, a summary of the actions of the Committee and a review of the status of various matters now pending before the Division, or in which it is involved.

In reporting that at a meeting of the Board of Directors of the Association of American Railroads held on March 27, 1936, it was decided that the effective date of interchange Rule 3, Sec. (t), Par. (4), for the retirement of arch-bar trucks, would not be extended beyond January 1, 1938, the committee reported that at the end of last year there remained 568,032 railroad-owned interchange freight cars and 96,624 private line cars, or a total of 664,656 freight cars, amounting to 29.1 per cent, equipped with arch-bar trucks. The committee presented an estimate that approximately 588,500 cars so equipped would still remain in service at the end of June this year.

The committee also reported that 50,420 railroad-owned and 3,079 private line cars were equipped with AB brakes as of March 31, 1936.

The report announced that the Locomotive Service Brotherhoods have completed the presentation of evidence before the Interstate Commerce Commission in their request for an order to require the application of mechanical stokers on all coal-burning locomotives, and that the railroads will start the presentation of their case on July 6. In the rehearing before the commission in connection with a complaint of the locomotive service brotherhoods asking for the application of power reverse gears on all steam locomotives, the committee announced that the rehearing was concluded on March 5 and that a brief for the railroads is being filed with the commission by the general council of the association.

During the opening session the division was addressed briefly by Assistant Chief Inspector Shirley, of the Bureau of Locomotive Inspection, Interstate Commerce Commission, Roy V. Wright, managing editor, *Railway Age,* L. W. Wallace, director, Division of Equipment Research, A.A.R., and A. G. Pack, formerly chief inspector, Bureau of Locomotive Inspection.

Mr. Shirley indicated the importance, in the interests of safety, of having the front cab windows securely fastened with bolts, instead of screws; also the use of shatter-proof glass in these windows. Snow and ice on the windows obscure vision in winter weather. Plenty of heat is available in the cab and measures should be taken to heat the windows and prevent ice forming on them. The engineman's compartment on other than steam locomotives is frequently too cold in winter, and

J. W. Burnett,
Chairman-elect

particularly so where metal floors are used. Means should be provided for insuring the maintenance of a reasonable degree of heat in such compartments. Steps should also be taken, he said, by the use of insulation or other measures, to eliminate the deafening noise in the cabs of other than steam locomotives.

In his remarks Mr. Wright congratulated the members of the Mechanical Division on the extraordinary way in which they had met the conditions created by the depression during the past few years. This applied, he said, not alone to the ingenuity with which they had increased the efficiency of their operations, but to progress made in the utilization of new materials and new types of equipment which have recently been developed. Two new challenges now confront the mechanical department officers and supervisors, said Mr. Wright. These are the problems in connection with the speeding up of both passenger and freight service to meet the new forms of competition and the problem of personnel training which the present depleted state of the mechanical-department forces has created. This, he said, required a renewed interest in apprenticeship and building up and educating the supervision within the department. In the latter connection, Mr. Wright expressed the hope that, with a continuance of the improvement in business conditions, next year might see a return to a convention with a large exhibit of the many new and improved features of equipment never before exhibited. This, he said, would afford an invaluable means of education for these men as well as for all railway officers.

L. W. Wallace explained his conception of the primary function of the Division of Equipment Research in developing data and investigating current problems which arise from time to time in connection with railway equipment. He stated that the division, of which he is the head, desires to supplement, and in no way to supplant, the work of the various committees of the Mechanical Division. The Division of Equipment Research has already cooperated with the Committee on Car Construction in connection with impact tests of the Pullman welded steel box car and has advised the Committee on Locomotive Construction regarding two or three proposed studies. Mr. Wallace solicited further opportunities to assist the Mechanical Division committees in securing engineering data, arranging programs of test procedure, developing estimates of cost and in every other way which may prove feasible. Mr. Wallace closed his remarks by outlining the general procedure and program of the present investigation of air conditioning and stated that 23 out of 30 railroads have already assigned special engineers to make an intensive study of railway air conditioning requirements and assist in the road tests which must be made before any final conclusions are drawn.

New Chairman Elected

Owing to the death of W. G. Black, vice-president, Chesapeake & Ohio, whom the Nominating Committee had proposed in its formal report as the candidate for the chairmanship for the ensuing two years, the committee named J. W. Burnett, general superintendent of motive power and machinery, Union Pacific System, for chairman and proposed no candidate for vice-chairman at this time. Mr. Burnett and the following members of the General Committee, to serve until June, 1938, were elected: F. W. Hankins, chief of motive power, Pennsylvania; R. G. Henley, superintendent of motive power, Norfolk & Western; F. R. Mays, general superintendent of motive power, Illinois Central; J. Purcell, assistant to vice-president, Atchison, Topeka & Santa Fe; A. L. Ralston, general mechanical superintendent, New York, New Haven & Hartford. O. A. Garber, the retiring chairman, was also elected to serve on the General Committee during the next two years.

Electric Rolling Stock

The subjects under consideration by the committee include (1) advantages of anti-friction bearings for electric locomotives and m.u. cars, (2) a summary of experience in steam heating of passenger-train cars while being handled by electric locomotives, (3) methods of treating traction-motor windings for protection and preservation of insulation, (4) the Pennsylvania type GG1 electric locomotive, and (5) electric locomotives placed in service during the year ending June 1936.

Anti-Friction Bearings

A questionnaire was sent to 13 railroads believed to have acquired experience with anti-friction bearings, asking what advantages they offered when used in traction motors, main journals of multiple-unit cars and electric locomotives, with respect to operation, maintenance and conduction of current through parts. A brief summary of the information gathered is, as follows:

"1—Anti-friction bearings on armatures have no apparent effect upon starting friction.

"2—When journals are equipped it is general practice to hold trains at stations with brakes where it was not necessary with plain bearings.

"3—There is no apparent difference in running friction and there has been no effect upon schedules.

"4—No energy saving has occurred.

"5—Only one of the four railroads reporting has had any failure resulting from passage of propulsion current through the bearings and no provision has been made for passage of propulsion current around the bearings.

"6—The information on cost of maintenance and the recommendations for the use of anti-friction bearings are not suitable for comment at this time.

"The committee believes there are one or two other roads which have had considerable experience with anti-friction bearings and it shall continue to seek information on this subject with a view to making a final and definite report next year."

Steam Heating and Air Conditioning

Four railroads submitted summaries of their experience in the steam heating of passenger train cars while being handled by electric locomotives. These included the Chicago, Milwaukee, St. Paul & Pacific, the New York Central, the Pennsylvania and the New York, New Haven & Hartford. The report includes the data supplied by the railroads and these data are summarized by the committee, as follows:

"When passenger train cars are being hauled by steam locomotives there is a large source of supply of steam for car heating

V. R. Hawthorne, Secretary

purposes in the locomotive boiler. Also this supply is available at high pressure, i.e., in most cases at around 200 lb. per square inch. Through the use of a reducing valve the desired pressure is supplied to the steam train line. In the past when rubber hose connections were practically the universal standard connection between cars the maximum pressure was limited to about 130 lb. per sq. in., since this was the limit the hose could be expected to withstand without premature failure.

"On electric locomotives it is necessary to have a boiler for the sole purpose of supplying steam for train heating or cooling purposes.

"Since the boiler, its auxiliaries, fuel oil tanks, water tanks, etc., take up valuable space in the cab and add weight, thereby making the layout and design of the traction apparatus more difficult and crowded, it is desirable to limit the size of this equipment, if possible, yet keep it adequate to handle the maximum train demand for heating or cooling without restricting the train length below the hauling capacity of the locomotive.

"The early electric locomotive boilers were built to operate at 100 to 120 lb. per sq. in. At that time many wooden cars were in use, trains were short, the connections between cars were rubber hose, the train line 1½-in. or less in some instances, and the gasket opening 1⅝-in.

"The present practice of the railroads to operate long trains of 16 or 18 cars or more at higher speeds and at the same time provide better conditions in the cars both in heating and cooling has created demands on the steam supply system that have necessitated revisions in its equipment as follows:

1—The use of a 2-in. train line and 2-in. metallic end connections between cars to permit passage of the required volume of steam with the minimum pressure drop.

2—New boilers being built for electric locomotives are designed for 200 or 220 lb. per sq. in. working pressure to provide sufficient pressure at the rear of long trains for steam heat purposes or air conditioning by the steam system, which requires 60 lb. per sq. in. at the rear car for proper operation. Note: For steam heating purposes only a maximum of 8 to 10 lb. has been considered sufficient at the rear car.

3—Adjustment of locomotive regulators to make possible the supplying of steam to cars at 175 lb. per sq. in. or higher.

4—To minimize drop between boiler and rear of the locomotive, pipe larger than 2 in. has been used in some cases.

5—The use of reducing valves on each car to maintain the pressure constant at the regulator, or the use of diaphragms in regulators capable of efficiently handling steam at all pressures from 0 to 200 lb. This to minimize waste of steam and consequent loss of pressure and capacity to heat the train.

6—Boilers of greater capacity are being provided in the electric locomotives now built. Recent ones have had normal ratings of 3,250 and 4,700 lb. of steam per hour from and at 212 deg. F. Under forced ratings twice this evaporation is available.

"The amount of steam required per car per hour varies with the particular type of car, the speed, the weather conditions, the condition of the train line and regulators with respect to leaks, adjustment, etc., and to the difference between the temperature in the car to the outside air. A fair average figure for design purposes for a car temperature of 70 deg. F. with outside temperature zero, and train line in good condition, is 200-250 lb. per hour. The exact value is dependent on the car insulation and whether the cars have single, double or triple windows, etc.

"For air conditioning by steam, about 250 lb. per hour per car is required. Since the outside air temperature is high when this equipment is used, the condensation losses are a minimum.

"It has been found that well insulated metallic end connectors reduce the loss approximately 10 per cent over uninsulated connectors. Aside from the heat economy standpoint this is the equivalent of an increase in boiler capacity since more cars could be satisfactorily handled by the same boiler. Further the water supply which is necessarily limited on electric locomotives is conserved, making possible longer trains or runs.

"Summarizing, it can be said that experience in heating or cooling of passenger trains being hauled by electric locomotives shows that ability to handle long trains is limited by the pressure available at the rear of the locomotive, train-line pressure conditions, and the capacity of the boiler to produce sufficient quantity of steam."

Treating of Traction-Motor Windings

Exhibit No. 3 of the report contained certain conclusions drawn by the Committee as a result of a questionnaire sent out to Committee members dealing with the methods used on electrified roads for the treating of traction-motor windings.

Electric Locomotives

Exhibit No. 4 of the report consists of brief descriptions of the class P5A and class GG1 electric passenger locomotives now in service on the Pennsylvania.

Exhibit No. 5 consists of a table covering electric locomotives placed in service during the year ending June, 1936. These are all Pennsylvania locomotives and consist of two switchers having a C axle arrangement, 27 type P5A passenger locomotives with a 2-C-2 axle arrangement, and 57 type GG1 passenger locomotives having a 2-C + C-2 axle arrangement.

The report is signed by R. G. Henley (chairman), superintendent motive power, N. & W.; J. H. Davis, chief engineer electric traction, B. & O.; J. W. Sasser, superintendent motive power, Virginian; R. Beeuwkes, electrical engineer, C.M.St. P. & P.; W. S. Hamilton, equipment electrical engineer, N.Y.C.; A. L. Ralston, general mechanical superintendent, N.Y.,N.H. & H., and H. C. Griffith, electrical engineer, Pennsylvania.

Action.—The report was accepted and ordered published in the annual proceedings.

Lubrication of Cars and Locomotives

Methods of Lubrication

Tests of various types of lubricators and methods of lubrication have been continued by a number of member roads. Reports received by the Committee so far have not developed anything of sufficient merit to warrant any recommendations at this time. Tests are still in progress and observations will be continued to ascertain definite operating performances.

During the extreme weather of the past winter there was a decided increase in delays to passenger trains on some roads due to hot boxes. Much of this trouble was due to moisture in the journal boxes, causing packing to freeze and roll out of position with resultant break down of lubrication. The past winter has emphasized the importance of and necessity for leak-proof dust guards and journal-box lids.

The present specification for dust guards does not provide a leak-proof guard, and your committee has now undertaken a study to determine the possibility of securing adequate dust-guard and box-lid protection for journal boxes. As various methods of sealing journal boxes are being experimented with by member roads, the committee would appreciate suggestions from members and manufacturers, of any new developments or devices of merit that are now being used or tested.

Journal Bearings

The new design of journal bearing known as the S.B.O.C. (Security Bond Oil Control), developed by National Bearing Metals Corporation, has been tried by a number of railroads and private car lines. Some member roads have requested permission to use this type of bearing in interchange as an equivalent substitute for the standard A. A. R. bearing.

This committee, after investigating the performance of these bearings, feels that they can be accepted as equivalent to the A. A. R. bearings in interchange and recommends accordingly.

Specifications for Reclaimed Car Oil

As a result of recommendation made in the 1935 report, the Committee on Specifications for Materials has reworded Specification M-904-36 and added two paragraphs describing apparatus and procedure for testing for extraneous solids.

This revised specification is submitted for adoption.

Interchange Rule No. 66

Examination of the condition of journal-box packing, bearings and wedges of freight cars, where the work had been performed as required by Rule 66, notably on equipment built during the past two years, indicated that the periodic repacking period could be extended without impairing the service. The Committee therefore recommends that consideration be given to an extension of three months beyond the present requirement of 12 months and 15 months. The extended period will then more closely coincide with air-brake cleaning dates, one repacking period equaling present air-brake cleaning period, and two repacking periods equaling one cleaning period for cars equipped with AB brakes.

There are still member roads and private car lines that use materials not meeting the A. A. R. requirements when repacking owned cars. It is felt that no further improvement in the hot box situation can be expected unless there is a unity of purpose upon the part of all car owners to insist upon full compliance with the requirements of the rules.

This Committee is strongly in favor of adding to Interchange Rule 3 a requirement that all cars in interchange must have journal boxes packed and stenciled in accordance with requirements of present Rule 66 and materials used must meet the requirements of the A. A. R. Standards; and respectfully recommend that the Arbitration Committee give this their consideration.

The question of application of new journal bearings in con-

nection with change of wheels and axles has been considered by the committee and it is recommended that if, in the judgment of repairing line, the old journal bearings may be safely re-used on the journals of axles applied, charge for new journal bearings on such axles is not justified. It is recommended that the Arbitration Committee give this matter consideration.

Renovated Journal-Box Packing

The committee has undertaken a review of present A. A. R. requirements for renovated journal-box packing as now contained in Rule 66, with a view to proposing changes to clarify and tighten up on the requirements, establish methods of sampling, testing and analyzing; and also to consider the advisability of proposing specifications for renovated packing.

The committee has no report on locomotive lubrication at this time.

The report was signed by G. W. Ditmore (chairman), master car builder, D. & H.; P. Maddox, superintendent car department, C. & O.; E. Von Bergen, general air-brake, lubrication and car-heating engineer, I. C.; H. P. Allstrand, assistant superintendent motive power, C. & N. W.; E. L. Johnson, assistant engineer of tests, N. Y. C., and J. R. Jackson, engineer of tests, Mo. P.

Action.—The report was accepted.

Prices for Labor and Materials

In order that the rules may currently provide an equitable basis for inter-road billing, the committee has continued the work of analyzing material, labor and new equipment costs in A.A.R. Interchange Rules 101, 107, 111 and 112 of the Freight Car Code, and Rules 21 and 22 of the Passenger Car Code, with a view of determining and recommending necessary changes to be made in the next supplement to the current Code.

Rule 101

All miscellaneous material prices in Rule 101 were rechecked as of March 1, 1936, quotations from purchasing agents of the 10 selected railroads, representing 39 per cent of total freight car ownership in the United States and Canada, indicating little change in material markets as shown by detail recommendations for revision under this rule. A slight increase in prices for bolts, nuts, forgings, castings, journal bearings, cast-iron wheels and axles is recommended, while a slight decrease is shown in prices for chain, nails, approved types of draft gears and larger sizes of pipe.

New Items 69 to 76 inclusive are added, to provide charge for extra heavy pipe fittings. New Item 121-B is added, to provide charge for "E" type 6¼-in. by 8-in. swivel-shank coupler (excluding swivel butt casting and pin). New Items 179 and 179-A are added, to provide prices for ¾-in. pipe.

First note following heading "Friction Draft Gears" on page 173 is modified to establish equitable credit in cases where approved type gears are substituted as correct repairs for non-approved types, in order that such substitution may not be penalized. Three additional types of non-approved draft gears are added to Section II of the table.

Rule 107

A new note is added to Item 21, to provide additional charge for raising and blocking truck and spring plank to apply rivets securing brake beam supports, when work is performed by this method.

Third note following Item 31, and Item 43, are modified to clarify the intent that the operations in question apply in connection with coupler stop casting rivets as well as bolts.

Third note following Item 270 is modified to make clear that charge for turning wheels may be made for defects which require turning, such as thermal cracks, etc., instead of being confined only to wheels which do not have full flange contour when removed or where fused metal has accumulated on treads.

First note following Item 281 is modified to restrict total charge for repairs by welding of those parts listed under Section (1) of Rule 104, to the second-hand allowance provided therein.

Item 295 is modified to clarify the intent with respect to charge for jacking car, when necessary in connection with work charged under this item.

Rule 111

No modifications are recommended in this rule.

Rule 112

No change in settlement prices for destroyed cars is recommended, due to the small number of cars built during 1935 and the fact that costs reported for hopper cars included a number of cars of special light weight design. Other costs reported vary but little from prices now listed in this rule.

Passenger Rule 21

A new last paragraph is added to first note following Item 26, to harmonize with third note following Item 270 of Freight Rule 107.

Passenger Rule 22

Changes in material prices in a number of items under this rule are recommended, based on quotations as of March 1 from the purchasing agents of ten representative railroads.

Item 2 is modified to cover the A.A.R. Standard and Alternate Standard passenger type brake shoes adopted by letter ballot last year.

It is the intent of the Committee to investigate labor and material costs again in October and if sufficient change develops, necessary revision will be made and inserted in the Rules effective January 1, 1937.

The changes recommended in the existing rules were shown in detail in the report.

The report was signed by A. E. Calkins (chairman) superintendent of equipment, N. Y. C.; H. H. Harvey (vice-chairman) general car foreman, C. B. & Q.; F. J. Dodds, general car inspector, A. T. & S. F.; P. Kass, superintendent car department, C. R. I. & P.; O. A. Wallace, supervisor car repairs, A. C. L.; T. J. Boring, general foreman, M. C. B. Clearing House, Pennsylvania; J. P. Egan, superintendent car inspection and maintenance, N. Y. N. H. & H.; H. H. Boyd, assistant chief motive power and rolling stock, Can. Pac.; A. E. Smith, vice-president, Union Tank Car Co., and A. H. Gaebler, superintendent car department, General American Transportation System.

Action.—The report was adopted.

Brakes and Brake Equipment

The following report is submitted for consideration:

Braking Ratios for Passenger Cars

This subject has been discussed with members of the Mechanical Advisory Committee of the Federal Co-ordinator of Transportation, the Director, Bureau of Safety, Interstate Commerce Commission, and representatives of the Westinghouse and New York Air Brake Companies, after which the following conclusions have been reached:

We have agreed that the question of braking ratios for passenger equipment cars be divided into two separate and distinct types of equipment.

A—That dealing with conventional passenger equipment cars.

B—That dealing with specially designed light-weight passenger equipment cars for and other cars operated in ultra-high speed service.

For *A* we recommend as a minimum requirement the present standard A. A. R. recommended practice which is a braking ratio of 90 per cent of the empty car weight based on 60 lb. brake cylinder pressure.

For *B* it is the view of your committee that higher braking ratios than specified in *A* for conventional equipment are necessary, but in view of the limited knowledge with respect to the necessary practical braking ratio requirements for such equipment it is obvious that data not yet available will be necessary before any definite minimum requirement can be established.

We also recommend that the present braking ratios for passenger cars as shown on page 7—Sec. E of the Manual, be advanced to standard with a revision to the caption inserting the word "Conventional" between the words "For" and "Passenger."

Braking Ratios for Locomotives

We have also agreed that these braking ratios be divided into two separate and distinct types of locomotives.

C—That dealing with conventional locomotives.

D—That dealing with locomotives designed for and other locomotives operated in ultra-high-speed service.

For *C* we recommend the following minimum braking ratios, all based on 50 lb. brake cylinder pressure:

	Passenger	Freight and Switch
Drivers	60 per cent	50 per cent
Trucks	45 per cent	45 per cent
Trailer	45 per cent	45 per cent
Tender	90 per cent	75 per cent

For *D* it is the view of your committee that higher braking ratios than specified in *C* for conventional locomotives are necessary, but in view of the limited knowledge with respect to the

necessary practical braking ratio requirements for such locomotives it is obvious that data not yet available will be necessary before any definite minimum can be established.

We further recommend the following locomotive braking ratios be adopted as recommended practice and included in the Manual:

BRAKING RATIOS FOR CONVENTIONAL LOCOMOTIVES

Recommended Practice

The following minimum braking ratios, all based on 50 lb. brake cylinder pressure:

	Passenger	Freight and Switch
Drivers	60 per cent	50 per cent
Trucks	45 per cent	45 per cent
Trailer	45 per cent	45 per cent
Tender	90 per cent	75 per cent

With reference to Par. *B* and *D*. It was the unanimous opinion that road tests would be necessary before any definite minimum braking ratios could be established for ultra-high speed passenger cars and locomotives, and it was decided that the committee would request the brake companies to prepare a tentative program of road tests and assist the sub-committee with its final preparation for recommendation.

Hose Nipples

Sometime ago this committee conducted an investigation in connection with air hose failures, which disclosed that as a rule burst hose resulted from manufacturers' defects or damage to the inner tubing, especially in mounting.

The question is now raised as to whether the use of former standard long nipples for 1⅜-in. air brake hose should be perpetuated or if they should be scrapped when hose are remounted and the present A. A. R. standard nipple used exclusively. The purpose of shortening the nipple and changing the contour at the non-threaded end was to minimize damage to hose tubing when hose are pulled apart without uncoupling.

The greater proportion of the above size nipples in service are of the present A. A. R. type and we are of the opinion that the results to be obtained from the use of the present standard justifies their substitution for the former long nipples in remounting air brake hose and recommend that the railroads consider making effective the general use of the present standard short nipple.

Air Brake Defect Card

Your committee feels that the demand for the defect card shown in the Manual does not exist at present and that its use has been generally discontinued, therefore, we recommend its removal from page E-9—1934, and all references thereto.

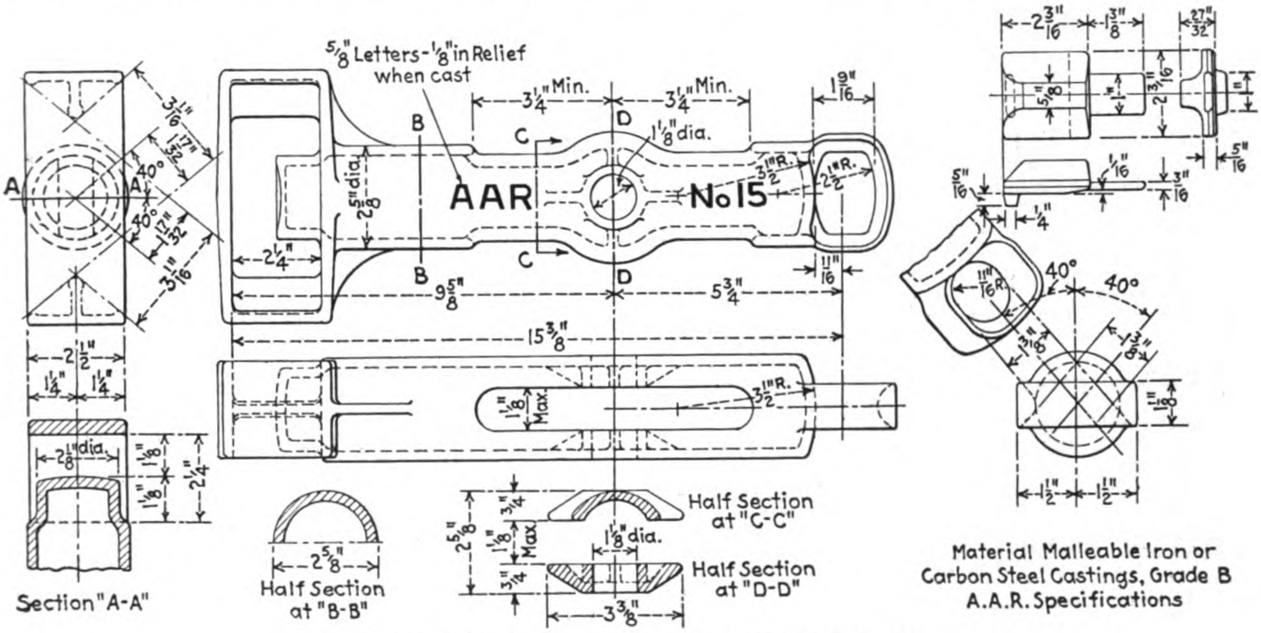
Lap-Joint Packing Rings for Triple Valves

Rule 134 in "Instructions for the Maintenance of Air Brakes and Train Air Signal Equipment" provides that main piston packing rings removed from the piston must not be re-applied. This rule was inaugurated at a time when the old type mitre-joint ring was the standard and was to prevent the re-use of rings which it was necessary to distort in using them in smaller sized cylinders in order that excessive clearance of the joint did not occur. In recent years the air brake companies have developed a new type lap-joint ring which has largely supplanted the above mentioned type and provision is made in the various sizes furnished for suitable clearance at the joint to prevent jamming of the ring ends, which resulted with the old type ring in an effort to fit the joints close enough to prevent ring leakage.

The new type ring has a specially designed lap joint which provides for considerable clearance at the joint without leakage, and within the limits of the permissible joint clearance may be re-applied. The air brake companies are now developing a gage to determine the suitability of rings of this type for re-application, after which it is our intention to recommend a modification of the above mentioned rule in accordance therewith.

Location of "AB" Brake Equipment

Numerous complaints have reached your committee relative to damage to "AB" control valves, particularly on house cars, due to end gates on trucks protruding under cars when backing up for loading and unloading, and hitting the "AB" valve located under or adjacent to the door opening. In conjunction with the Car Construction Committee arrangements have been made to revise Plate 516-A of the supplement to the Manual to provide for the "AB" valve being located at least 24 in. from one side of the door opening. When the width of the door opening or other structural condition makes this impossible, we recommend a substantial shield to protect the valve.



Approved reversible brake-beam strut—American Steel Foundries

Braking Ratio for Light-Weight Freight Cars

The question of braking ratios for light-weight, high-capacity freight cars has been considered by a sub-committee and after discussions with the air brake companies and the Mechanical Advisory Committee to the Federal Co-ordinator of Transportation, it was agreed that the tentative recommendations for braking ratios of light-weight cars was satisfactory.

In view of this action we recommend the following braking ratios for new freight cars:

"The braking ratio for freight cars equipped with empty-and-load brakes shall be not more than 60 per cent of the light weight of car based upon 50 lb. brake cylinder pressure.

"The braking ratio of such loaded cars shall be 30 per cent of the marked nominal carrying capacity plus the light weight of the car, based upon 50 lb. brake cylinder pressure.

"When the marked nominal carrying capacity of freight cars is more than three times the light weight, such cars shall be equipped with an approved design of empty and load brake."

We further recommend that the above requirements be adopted as recommended practice and embodied in the Manual.

Brake Beams

Maintenance and Inspection of Beams and Attachments.—During the past winter numerous complaints have been received relative to failures of brake beams, hangers and attachments, brake beam supports, bottom rods, etc., which have, in many instances, resulted in considerable delay and interruption to traffic. The unprecedented weather throughout the past winter has, no

doubt, aggravated this situation; however, an inspection of these items would indicate that roads generally should establish a suitable campaign in inspection and repairs to these devices in order that hanger pins, bolts, cotters, keepers and various supporting members will be carefully inspected and such corrections made as will relieve this situation.

In many instances improper size and poorly made bolts, pins and cotter keys or keepers are found and the lack of their proper anchoring by spreading so that they are secure to avoid wear and loss. Poor materials and workmanship are common in the fabrication of many hangers, pins, safety supports, etc., which leads to their rapid failure in service.

The committee feels that this is of such importance that greater care should be exercised and closer inspection given the fabrication of all parts comprising the truck foundation brake gear and suggests the application of designs and materials which offer the greatest security to long life and absence of failure.

Numerous failures have been traced directly to brake hangers, pins and materials used in bolts, rivets, etc., which have been found badly burned and fractured during manufacture. Close observance should be given to the requirements of present Interchange Rules regarding inspection of the above items when repairs or renewals are made.

The loop type of brake hanger eliminates the necessity for hanger pins, cotter keys or keepers, such as are generally used and we urge the use of this type hanger so far as possible.

In order that the matter might be brought to the attention of the entire membership, the committee has, at the request of the General Committee, suggested a circular for general distribution and we urge the railroads to observe the recommendations contained therein in order to alleviate, as far as possible, the troubles incident to lack of maintenance of foundation brake gear upon freight equipment.

Specifications for Repairs to Brake Beams.—During the early part of last year a joint subcommittee representing the Arbitration, Car Construction and Brake Equipment Committees, began the preparation of specifications for repairs to freight brake beams. This joint subcommittee has prepared and submits herewith a Specification for Repairs to Freight Equipment Brake Beams which, it is felt, will result in a reconditioned beam of reasonable satisfactory service life expectancy and which will eliminate many failures now experienced as result of secondhand brake beam applications. The specification provides for a proof test for the individual beam and identification marking as a guarantee of repairs in accordance with the provisions of the specification and prescribed test. [Specifications which were included in Exhibit A of the report are omitted in the abstract.—EDITOR.]

A cost work-up of beams repaired under the new specification, based on actual time study, indicates the present secondhand allowance of 65 per cent of price new, should be increased to 70 per cent of price new for the specification repaired beam; and the average credit value reduced from 30 per cent to 23 per cent of price new.

If the specification is adopted as Standard Practice, it is recommended that the Arbitration Committee modify the Interchange Code to provide prices for new beams, for repaired beams per Standard Specification and Test and for average credit value —in lieu of the present new, secondhand and average credit allowances. Also, to provide that secondhand beams which have not been reworked, or which have not been repaired and tested in accordance with the specification, if applied to foreign cars, shall be charged at the average credit allowance.

The proposed specifications have been approved by the Arbitration Committee, Committee on Car Construction and Committee on Brakes and Brake Equipment, with recommendation that same be submitted to letter ballot for adoption as Standard Practice, effective January 1, 1937.

Reversible Brake Beam Struts or Fulcrums.—From time to time requests have been made for approval of reversible struts of various types. Recently the American Steel Foundries submitted drawings and description covering a reversible strut suitable for the No. 15 A. A. R. standard brake beam. A strut of this character provides for the elimination of one brake beam, i.e., right or left hand, from the stock of beams necessary to carry to take care of repairs to freight equipment and at the same time embodies a one-piece strut possessing the strength and rigidity common to that of the present standard strut.

After considering the request of the American Steel Foundries for approval of a strut of this type and the advantages which it possesses, the committee has given its approval for its use to encourage, so far as possible, the standardization of brake beams and related parts.

The report was signed by G. H. Wood (chairman), supervisor air brakes, A. T. & S. F.; W. H. Clegg (vice chairman), chief inspector air brakes and car heating equipment, Can. Nat.; R. E. Baker, general air brake inspector, B. & M.; T. L. Burton, air brake engineer, N. Y. C.; M. Purcell, general air brake inspector, No. Pac.; C. H. Rawlings, general air brake instructor, D. & R. G. W.; M. A. Kinney, general master mechanic, C. & O.; R. C. Burns, general foreman, Penna.; L. S. Ayer, general air brake inspector, So. Pac., and J. P. Stewart, general supervisor air brakes, Mo. Pac.

Discussion

J. W. Burnett, Union Pacific, offered the committee the extensive data on the brake performance which has been developed from tests of the high-speed trains on that road. This the committee was glad to accept.

R. L. Kleine, Pennsylvania, questioned the desirability of prohibiting the restoration of worn surfaces of brake heads by welding, which was the apparent intent of Paragraph (c) of Section III of the Specifications for Repairs to Freight Equipment Brake Beams, in exhibit A of the Committee Report. He said that no trouble had been experienced with brake heads of malleable iron and steel restored in this way. J. McMullen, Erie, was not in favor of the use of welded brake heads except on home cars. W. H. Clegg, Canadian National, said that, while some welding was good, not all of that done around car departments was satisfactory. Considering the price of new brake heads, he did not consider the economy was great enough to justify permitting the welded brake heads to be used on other than system cars. On motion of Mr. Kleine, the paragraph of the Specifications in question was referred back to the committee to be revised to specify limits of wear within which welding is permissible.

Action—Subject to the above change, the report was accepted and referred to letter ballot.

Air Conditioning and Equipment Lighting

A comprehensive and detailed series of tables covering air-conditioned cars now in service constitutes a major part of the report. The data are classified in four ways: (1) types of cars, (2) types and kinds of air-conditioning systems, (3) types of motor drive, and (4) capacities of generators with respective types of drive.

In addition to this, the committee gave particular attention to the question of voltage of power supply to railway passenger cars. Concerning this subject, the committee offers the following for information and guidance for future study:

"In the past several years there has been a gradual increase in general demand for electric power as supplied by the 32-volt axle-driven generator and battery equipment on passenger cars. Generally speaking, to take care of this situation axle generator equipments have been duplicated or have been increased by 2 to 5 kw. each, and batteries have been increased by 200 amp.-hr. to 600 amp.-hr. capacity.

"With the introduction of electrically operated air-conditioning equipment on railway passenger cars using the 32-volt system, it has been necessary to either increase the 32-volt axle generator from 5 kw. to 10, 15 or 20 kw., and increase the battery capacities to 1,000 or more amp.-hr., or install an additional 32-volt axle generator and battery of sufficient capacity to take care of that load independently of the lighting and other auxiliary load.

"There has been no particular difficulty with the satisfactory operation of the so-called 32-volt axle generator equipment and battery, but if the extended use and increase in 32-volt generator capacity is to be practically met, some other system of higher-voltage generation and power distribution must of necessity be considered.

"The committee feels that the general public is becoming more and more accustomed to a high intensity of illumination in their homes and places of business, and for this reason expects the railroads to provide illumination of comparable intensity in their passenger cars. Also, the trend to artistic effects in illumination naturally calls for a greater amount of power to obtain the effects desired. Therefore, as noted above, there seems to be a well founded reason why the demand for power will steadily increase. Serious consideration should be given to the study of a suitable system of electric power generation and distribution that will take care of this phase of passenger equipment in railway service for some considerable time. Obviously, a power generating and distributing system designed to supplant the present 32-volt system will be far-reaching and expensive. The subject should be approached slowly and deliberately, and the situation studied and watched very closely, at least for the next year or two.

"As a matter of preliminary information, there are several power and voltage systems which can be used to replace the 32-volt axle generating system, i.e.:

"1—The 64-volt generator system will increase the capacity and double the number of cells. Because of the higher voltage, the transmission of power with smaller size wires will be possible, but this system would probably only take care of the situation for a short time under the present rate of increase in the electrical load.

"2—The 110-volt axle generator system will increase the capacity but requires three and one-half times as many cells of battery as the 32-volt system, and one and three quarters times the number of cells required by the 64-volt system.

"The 110-volt system requires 55 cells of battery and, therefore, the question of weight and battery space under the passenger car seems to be a serious handicap. Again, if air conditioning by electricity is to be extended, this system would not seem adequate.

"3—The third system, which would appear at the present time to give promise of a more permanent nature, would be the centralized independently driven 440-220-volt, three-phase, 60-cycle generating power plant located at the head end of the train, the current transmission being carried to each car by means of a three-phase, 220-volt, 60-cycle train line. With this 220-volt a.c. system the present 32-volt batteries and lights could remain as at present. Some changes would possibly have to be made, substituting universal type motors for the present 32-volt fans and other auxiliary equipment, which could be operated on either 32-volt d.c. or 32-volt a.c. A small transformer could be placed in each car to reduce the 220-volt a.c. to 32-volt, and a motor-generator set, converter, or rectifier unit installed for battery charging from the 220-volt, three-phase line.

"The 220-volt, three-phase, 60 cycle power generating and distribution system will also fit in with the present trend of power generation and distribution on streamline trains and Pullman stand-by services. In fact, cars now equipped with the 220-volt, three-phase stand-by motors, could be operated direct from the central plant, eliminating the mechanical drive.

"Two hundred-twenty-volt, three-phase, 60-cycle power is the universal commercial power used and no difficulty would be experienced in obtaining stand-by power at practically all yards, terminals and lay-over points. A centralized power plant and 220-volt system would take care of power requirements indefinitely."

Plugs and receptacles for making connections to air-conditioned cars from outside power sources are not fully interchangeable. To correct this condition, the committee has included drawings of plugs and receptacles, and it recommends the adoption of these as recommended practice.

The report is signed by W. E. Dunham (chairman), superintendent car department, C. & N.W.; E. Wanamaker, electrical engineer, C.R.I. & P.; A. E. Voigt, car lighting engineer, A.T. & S.F.; F. O. Marshall, electrical engineer, Pullman Company; P. J. Callahan, supervisor car and locomotive electric lighting, B. & M.; O. M. Bixby, assistant engineer, N.Y.C.; I. V. Goodman, assistant electrical engineer, Pennsylvania; and G. W. Bebout, electrical and shop engineer, C. & O.

Action.—The report was accepted and the recommendation regarding a plug and receptacle for stand-by power connections was ordered submitted to letter ballot.

Safety Appliances

Standard specifications covering geared hand brakes, as recommended by the Committee on Brakes and Brake Equipment, and the Committee on Car Construction, were approved for standard practice by letter ballot, December 18, 1935, to become effective March 1, 1936.

Automatic Train Line Connectors

The Joint Committee on Automatic Train Line Connectors of the Operating and Mechanical Divisions, at a meeting on September 10, 1935, unanimously recommended that laboratory tests of the two connectors that have given the most satisfactory performance under the tests conducted to date be continued to develop the performance of these devices under snow and ice conditions. They also recommended that H. A. Johnson continue as Director of this investigation, and that report covering the tests of the automatic train line connectors will not be made to the member roads of the Association, or to the Interstate Commerce Commission, until after the tests of the two selected devices, under ice and snow conditions, are completed.

H. A. Johnson reported, under date of April 8, 1936, that "The train line connectors which were used in the ice and snow tests in the Monon yards have been taken apart and examined for the effect of weather and the tests which were run on them. Laboratory tests on the oscillating machine were run on the Robinson ball and funnel and the Johnson type passenger train line connectors which have been exposed to weathering conditions since last fall. The tests are now completed and the report is being prepared."

Metal Running Boards

Copies of report covering the inspection and tests of metal running boards, to which was attached a tabulation covering information relative to the weight, cost, maintenance, and life of metal running boards, compared with wooden running boards, were sent to all members of the General Committee and the Committee on Safety Appliances. This report was received as information by the General Committee at its meeting on November 7, 1935.

The report was signed by Chairman R. G. Henley, superintendent motive power, Norfolk & Western; Vice-Chairman F. W. Hankins, chief of motive power, Pennsylvania; C. J. Bodemer, superintendent machinery, Louisville & Nashville; F. H. Hardin, assistant to president, New York Central; J. Purcell, assistant to vice-president, Atchison, Topeka & Santa Fe, and J. J. Tatum, general superintendent car department, Baltimore & Ohio.

Action—The report was accepted.

Specifications for Materials

The committee during the past year has reviewed a number of the specifications and considered comments and criticisms submitted by members of the Association or others.

At the request of the Secretary, this committee has reviewed the action taken by the Purchases and Stores Division in standardizing tinware, and approves this action.

1—Specifications M-101-34, Axles, Carbon Steel, for Cars and Locomotive Tenders.

In paragraph on Workmanship, 9 (b), change the last sentence, which now reads "The rough turning shall be done with a broad-nosed tool so that the surface is free from chatter marks," to read

"The rough turning shall be done so that the surface is free from objectionable ridges and chatter marks."

While this wording is somewhat general it is believed that it will take care of some of the objections that have been raised to the present wording.

2—Specifications M-108-34, Boiler Tubes, Lap-Welded and Seamless Steel and Lap-Welded Charcoal Iron.

The revision of these specifications has been principally to bring them into line with other standard specifications and current practice, but it also seems desirable to expand the scope so as to include electric-resistance-welded tubes which have been put into use by a number of railroads.

3—Specifications M-109-34, Structural Rivet Steel and Structural Rivets.

These specifications have been revised principally to bring the tables of dimensions and tolerances into agreement with those of the American Standards Association and eliminate the steeple headed rivets.

4—Specifications M-110-34, Boiler Rivet Steel and Boiler Rivets.

In order to cover the present practice of cold forming and normalizing of rivet heads used by certain manufacturers, Par. 2 (b) has been changed to read as follows:

"(B) Rivet heads may be hot formed or cold formed and normalized."

5—Specifications M-111-34, Welded and Seamless Steel Pipe.

These specifications have been revised to include electric resistance welded pipe, and provide for test of galvanized pipe.

6—Specifications M-115-34, Boiler and Firebox Steel for Locomotives.

On account of some misinterpretation of the meaning of the carbon range on firebox steel, this has been changed so as to eliminate the minimum.

7—Specifications M-118-34, Coupler and Knuckle Pivot Pins.

On account of the average of the present carbon range 0.55 to 0.75 per cent coming above the limit of 0.60 and thereby causing an extra classification, the carbon range has been changed to read

"0.52 to 0.67 per cent."

8—Specifications M-201-34, Steel Castings.

The following changes are made in order to clarify the meaning of the paragraphs affected.

Par. 14, in the last sentence insert the word *apparently* between *and* and *suitable*, making this read *and apparently suitable*, etc.

Par. 15 (a), change the last sentence to read *or to the dimensions predicated by the pattern*, etc.

9—Specifications M-301-34, Iron and Steel Chain.
M-302-34, Refined Wrought Iron Bars.
M-304-34, Staybolt Iron, Hollow Rolled.
M-305-34, Staybolt Iron, Solid.
M-306-34, Welded Wrought Iron Pipe.

In all of the above specifications change the maximum manganese from 0.05 per cent to read 0.06 per cent. This is in accordance with recent discussion with the wrought iron manufacturers and agreement that the present 0.05 per cent maximum manganese was unduly restrictive.

10—Specifications M-304-34, Staybolt Iron, Hollow Rolled.

Par. 5, *Tension Tests.* Add a new Par. (c), reading as follows:

"(c) In calculating the tensile strength, yield point and reduction of area, the area of a 7/32-in. hole shall be deducted from the area of the bar."

11—Specifications M-305-34, Staybolt Iron, Solid.

In Par. 5, Tension Tests, insert new paragraphs, (c) and (d), reading as follows:

"(c) For bars 7/8 in. down to 11/16 in. diameter inclusive, a minimum elongation of 28 per cent shall be permitted; for bars 5/8 in. and less in diameter, a minimum elongation of 25 per cent shall be permitted."

"(d) For bars over 1¼ sq. in. in sectional area, the following deductions from the minimum requirements specified in Section 5 (a) shall be made for each square inch of nominal section above 1¼ sq. in.:

Tensile strength—250 lb., but not under 46,000 lb. per sq. in.

Reduction of area—3 per cent, but not under 40 per cent.

12—Specifications M-605-34, Steam and Hot Water Hose.

On account of the difference in effect between the rack and the digester test, Par. 8 (b) has been changed to permit somewhat greater deterioration in tensile results when the digester test is used, as follows:

"(b) After the steam test, an increase or decrease of not more than 40 per cent from the original results will be permitted in tensile strength and elongation of tube and cover when the rack test is used, and not more than 50 per cent variation when the digester test is used."

Recommendations

The committee recommended that the above revisions in specifications be approved for submission to letter ballot.

The report was signed by: F. M. Waring (chairman), engineer of tests, Penna.; T. D. Sedwick (vice-chairman), engineer of tests, C.R.I. & P.; C. P. VanGundy, engineer of tests, B. & O.; Frank Zeleny, engineer of tests, C.B. & Q.; H. G. Burnham, engineer of tests, Nor. Pac.; J. C. Ramage, engineer of tests, Southern; H. W. Faus, engineer of tests, N.Y.C.; E. E. Chapman, engineer of tests, A.T. & S.F.; H. P. Hass, engineer of tests, N.Y.N.H. & H.; J. R. Jackson, engineer of tests, Mo. Pac.; H. G. Miller, engineer of tests, C.M.St. P. & P.

Action.—The report was accepted and the recommendations ordered referred to letter ballot.

Loading Rules

As the result of meetings held with shippers and investigations conducted during the past year, the committee recommended changes in the loading rules as shown below. In connection with the general rules, the suggestion was made to eliminate the words in parenthesis, (1 to 19) in the heading on page 12 since this is taken care of in the second sentence of Rule 1.

Rule 1

Change second sentence of Rule 1 to read:

"Special instructions must be procured from the originating carrier for shipments on open top cars not covered in these rules, and exacting care must be exercised to see that the details in Rules 1 to *21,* inclusive, are complied with in connection with all loading, except as otherwise specified in this code of rules."

Reason: To include Rule 20 as contained in Supplement No. 2 and to provide for new Rule 21.

Rule 3

Change to read as follows: *"Clearance—Side Bearing*—Trucks must curve freely and the average clearance between side bearings must not be more than ¼ in., or less than 1/8 in. per side bearing per truck."

Reason: To harmonize with the present wording in the Manual on Page 3, Sec. C, of the 1935 revision.

Rule 6

Change to read as follows:

"Weight of Load (Rule 4), on Bearing Pieces With or Without Sliding Pieces.

(a) Weight carried on one bearing piece per car should not exceed the percentage of stenciled load weight limit, as shown in columns 7 and 8 of Tables No. 18 to 50, inclusive, depending on the class of car as shown in the table.

(b) Weight carried on top of gondola car sides between body bolsters must not exceed one-half of the load limit of car. Height of loads on top of gondola car sides, measured from top of rail to center of load must not exceed 9 ft. 3 in. at bearing pieces. Short material underneath load on top of gondola cars must be equally distributed over car floor, but the entire load on wooden underframe cars must not exceed three-fourths of the load limit of car.

(c) Lading on top of gondola cars with wooden sides less than 3 in. thick, or steel gondola cars with sides not sufficiently strong to carry load is prohibited. Corner stakes of cars with drop ends must be suitably reinforced for loads on top of sides, except when especially prepared for the particular lading."

Reason: To conform with two new columns in Tables 18 to 50.

Rule 8

Change Sec. (d) to read:

"Provide 4 in. clearance between underside of load and car, for loads on two or more cars; also for that portion of loads overhanging idler cars."

Reason: To clarify the intent.

Rule 10

Change second paragraph Sec. (c) to read:

"When boards are specified, use at least one 1 in. by 5 in., for each pair of stakes for load 12 in. or less above top of car sides, and at least two such boards to each pair of stakes for load over 12 in. above top of car sides; *using* three 10-D nails *in each end of each board."*

Reason: To clarify the intent.

Rule 14

Change Sec. (b) to read:

"Nails treated to increase holding power, preferred. The length shall be such as to prevent them being driven through sides or ends of cars."

Reason: To broaden the scope.

Rule 16

Change to read as follows:

"Loads on One Car Overhanging One or Both Ends—Width, Height and Length.

(a) Table 1 shall govern in deciding the maximum width according to length of overhanging loads on single cars. For intermediate lengths of cars, not listed in this table, the maximum length and width of overhanging loads as shown for the next longer car shall govern. Determine length of cars by measuring to outside face of end sills. The total length of lading must not exceed the limits as shown in Tables 2 to 17, inclusive—Rule 17.

(b) The overhang is measured from center of truck to extreme end of overhang. For loads over 12 ft. high from top of rail to top of load, the given width must be reduced 2 in. for each inch in height for that portion of load in excess of 12 ft.

Table now in Rule 16, should be changed to Table 1, in the new book."

Reason: To clarify the intent.

Rule 17

Change to read as follows:

"Weight Restrictions for Loads on One Car Overhanging One or Both Ends.

(a) Tables 2 to 17, inclusive, shall govern in deciding the maximum weight of loads overhanging one or both ends of a car. Long steel, liable to take permanent set by bending must rest on sufficient bearing pieces to prevent sagging.

(b) Allowable weight on cars of intermediate lengths not specified in tables, should be obtained by adding one-fourth the difference between the weights shown for the next shorter and longer car to the weight shown for the shorter car, for each six inches more than shown for the shorter car.

(c) Allowable weights of intermediate lengths of material not specified in tables, should be obtained by adding one-fourth of the difference in weight shown for next shorter and longer length of material, to the weight shown for the shorter length, for each six inches more than shown for shorter length.

(d) The length of overhanging pieces may be determined by the average length of the pieces in that portion of the load.

(e) Material, uniform weight throughout and uniform length and width of portions overhanging both ends of one car, and not supported on sliding pieces, may be loaded to load weight limit of car."

Reason: To economize for shippers.

Rule 18

Change to read as follows:

"Load on Two or Three Cars—Width, Height, Overhang.

(a) The width of load, distance between bearing-pieces, and length of overhang must not exceed the dimensions shown in Tables 18 to 50, inclusive, for loads 12 ft. high or less, measured from top of rail to top of load. For loads over 12 ft. high from top of rail to top of load, the given width must be reduced 2 in. for each inch in height for that portion of load in excess of 12 ft. For loads of uniform width throughout length of load, the minimum width "W" is to apply.

(b) When cars of different lengths are used for the same load, the maximum width of load shall be as shown in the tables for longest carrying car used.

(c) For cars of intermediate lengths not shown in the tables, the maximum width of loads on carrying cars must be governed by the next longer car shown in the tables. Determine length of cars by measuring to outside face of end sills.

Note: The above mentioned tables are based on 10 ft. 6 in. clearance width limits, 15 deg. curvature, and 3 in. tolerance on each side of load."

Reason: Reference to coupler spacing blocks, etc., eliminated account taken care of by new Rule 21. New paragraph (a) provided to eliminate duplicate printing.

Add sketch "Arrangement of Load on Two or Three Cars, per Tables 18 to 50 Inclusive."

Reason: To make it possible to eliminate sketches shown on pages 27, 29, 31, 33, 35, 37, 39, 41, 43 and 46.

Add two columns to Tables 18 to 50, inclusive, to show percentage of permissible load weight.

Reason: To improve the rule.

Rule 19

Both old and new heading, now shown in Supplement No. 2. Eliminate old heading, also the wording "Rule changed to read as follows:"

New Rule 21

To read as follows: "Coupler-Preparation of.—Apply coupler spacing blocks, per Fig. 3, and make uncoupling mechanism inoperative per Fig. 4, when load is carried on one or more cars with overhang resting on sliding pieces on idler car, and when load is carried on more than one car."

Reason: To eliminate duplicate printing in other rules and figures.

[The report at this point included recommended changes in loading practice as specified in 39 figures, with the usual objectives of providing better loading, to save shipper expense, economize in printing, etc. These changes applied to Figs. 2, 3, 4, 6, 9, 30, 47, 48, 70, 81, 85, 86, 87, 96, 115, 131, 136, 137, 138, 145, 146, 147, 153, 154, 156, 159, 165, 166, 167, 168, 170, 171, 176, 179, 180, 183, 186, 187, and 188, inclusive. Three new figures, namely, Figs. 201, 202 and 203, were added to provide for the loading of pulp grinder stones on gondola or flat cars, and new Figure 209A, to provide an alternate method of loading boxed automobiles on gondola cars.—Editor.]

The report was signed by Chairman Samuel Lynn, superintendent rolling stock, Pittsburgh & Lake Erie; Vice-chairman E. J. Robertson, superintendent car department, Minneapolis, St. Paul & Sault Ste. Marie; R. H. Dyer, general car inspector, Norfolk & Western; G. R. Lovejoy, master mechanic, Detroit Terminal; T. O. Sechrist, assistant superintendent machinery, Louisville & Nashville; C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau; H. S. Keppelman, superintendent car department, Reading; W. B. Moir, chief car inspector, Pennsylvania; J. A. Deppe, assistant superintendent car department, Chicago, Milwaukee, St. Paul & Pacific.

Discussion

Mr. Lynn, the committee chairman, in presenting the report said that the work of the committee during the past year had largely been devoted to efforts to reduce the cost to the shipper of compliance with the rules. He pointed out the importance to the railways of this item of total transportation cost as a factor in their competition with other forms of transportation. The shippers, he said, are being forced to ask the committee to make changes, which formerly they would not have asked, to meet not only their own requirements but the requirements of their customers. He cited as an instance the matter of loading sheet steel on flat cars because it is cheaper to unload from the flat car than from the other types. This, he said, was one of the subjects now under consideration by the committee. He pointed out that the shippers willingly co-operate with the committee and were going to considerable expense to demonstrate the safety of proposed changes in methods of loading. Much as the committee feels its responsibility in reducing loading costs, he said, every member of the committee has constantly before him as the first consideration in its work the necessity for safety. It was pointed out that the minimum requirements for securing lumber on flat or gondola cars in connection with figure 6 in the committee's report, while this method is an improvement, it still requires additional fastening in the case of dressed lumber to prevent it from spilling. C. J. Nelson of the committee said that the members were aware of this situation and were convinced that it could not be dealt with satisfactorily without additional expense to the shipper. He said that experiments with steel bands, which are now being made, should be encouraged and promised the full co-operation of the committee.

Action.—The report was accepted and the recommendations referred to letter ballot.

Arbitration Committee

As a result of letter-ballot action in 1933, the coupler manufacturers were directed to scrap their patterns for Type D coupler bodies, due to the Type E coupler having been adopted as Standard by the Association in 1931 as a distinct improvement over Type D coupler. However, the manufacturers continue to receive orders for the latter type and, upon suggestions by the Committee on Couplers and Draft Gears, a new requirement is recommended under Rule 3, effective January 1, 1937, prohibiting Type D couplers cast after August 1, 1936, on all cars in interchange.

A second new requirement is recommended under Rule 3, making the defect card receptacle mandatory for cars built new or rebuilt on or after January 1, 1937, as a safety measure and to facilitate inspection in interchange. The cost is little more than for the cardboard used for this purpose and many recommendations urging the use of the receptacle have been received from railroad clubs and car inspectors.

No further extension in effective date beyond January 1, 1937, has been recommended for requirement in Freight Rule 3 for the A.A.R. Standard draft key retainer, or approved equivalent. This recommendation is in the interest of safe operation and has the concurrence of the General Committee. No further extension in effective dates beyond January 1, 1937, has been recommended for requirements in this rule concerning stake pockets on flat cars. No requests for extension of these dates have been received and the committee feels ample time has elapsed to permit compliance. In accordance with 1934 letter ballot action, no further extension beyond January 1, 1937, will be granted for requirement prohibiting acceptance of Class E-4 cars from owners.

In accordance with recommendation by the Committee on Brakes and Brake Equipment, as approved by letter ballot last year, recommendations for modification of Rules 19 and 62 are submitted, to provide that, effective January 1, 1937, the new reinforced-back brake shoe per 1935 specification, must be used in repairs to foreign cars to justify bill.

Upon recommendation by the Joint Subcommittee on Material Charge for Secondhand Details, consisting of representatives of the Mechanical and Purchases and Stores Divisions, your committee has listed fifteen additional items for which charge is recommended on basis of 50 per cent of value new, when applied, secondhand, in repairs to owner's defects or on authority of defect card. It is felt this basis provides an equitable allowance for such secondhand material.

No further extension in effective date beyond January 1, 1937, is recommended for the requirement in Passenger Rule 2 which provides that cars other than passenger-carrying equipment must be equipped with metallic steam-heat connectors. No requests for extension of this requirement have been received and it is felt sufficient time has elapsed to permit compliance insofar as the above cars are concerned. In the case of passenger-carrying equipment, a one-year extension in effective date is recommended.

The committee does not feel that any of the modifications included in its report necessitate submission to letter ballot, the majority of them being routine and covering changes recommended by the Committee on Car Construction, Committee on Couplers and Draft Gears, Committee on Brakes and Brake Equipment and the Committee on Tank Cars, extension of effective dates of various requirements and changes necessitated by letter-ballot action last year.

The matter of complaints as to failure of secondhand brake beams was referred to in the 1935 report, with advice that a specification for reclaimed beams had been prepared by a joint subcommittee (consisting of members of the Arbitration, Brake and Car Construction committees), and that the report of this joint subcommittee had been approved, subject to review of prices by the Committee on Prices for Labor and Materials and approval of the method of repairs by the Committee on Car Construction. These recommendations will appear in the 1936 report of the Committee on Brakes and Brake Equipment. If

the specification is approved by letter ballot, this committee will immediately formulate the necessary changes suggested for the Interchange Rules.

During January, 1932, an investigation of the cost of accounting for car repairs was authorized by the Board of Directors of the Association and conducted under the direction of your committee. Copy of progress report of this investigation was mailed to member roads in July, 1933, and dealt, specifically, with the question of establishing central or regional clearing houses for the preparation and checking of car repair bills. Final report of the Special Subcommittee on Economies in connection with Cost of Billing for Foreign Freight Car Repairs, which also deals with the question of elimination of car repair billing, has been submitted and both the report and conclusions reached were unanimously approved by the General Committee. Copies of this final report were distributed to member lines on February 26, 1936. An abstract of same has been prepared and is printed as Exhibit B to this report.

All recommendations for changes in the Rules of Interchange submitted by members, railroad clubs, private car owners, etc., have been carefully considered by the committee and, where approved, changes have been recommended.

Attention is again directed to the fact that the Arbitration Committee will not consider questions under the Rules of Interchange unless submitted in the form of Arbitration Cases as per Rule 123.

Freight Car Rules

Rule 3

The committee recommends that effective dates for various requirements in the present rule, as listed below, now set at January 1, 1937, be extended to January 1, 1938:

Section (a) Paragraph (7)—Axles under 70,000 lb. capacity cars.

Section (b) Paragraph (6)—Brake-beam hangers with eyes not formed solid.

Section (b) Paragraph (8)—Bottom-rod and brake-beam safety supports.

Section (r) Paragraph (3)—Hatch covers to be secured by hinges.

Section (t) Paragraph (8)—Head-block anchorage on tank cars.

Section (t) Paragraph (9)—Wood shims between longitudinal anchorage and underframe, on tank cars.

Section (t) Paragraph (14)—Dome covers secured by hinge or chain, on tank cars.

Section (t) Paragraph (16)—Class I tank cars prohibited in interchange.

The committee recommends that Paragraph (3) of Section (t) of this rule be modified to add *excessive corrosion* to the conditions which prevent the substitution of second-hand cast steel truck side frames.

The committee recommends that Paragraph (15) of Section (t) of this rule be modified by substituting the term *car structure* for *underframe* and by replacing the reference to the A.A.R. Specification for *Class III, Tank Cars, effective May 1, 1917, to July 1, 1927,* with reference to Specifications for *Tank Cars, effective March 1, 1931.*

The committee recommends that the first note following Paragraph (1) of Section (u) of this rule be modified by adding the words *or equivalent strength* at the end to accord with the fact that with the use of Cor-Ten steel the net area of center-sill section may be reduced from 21.3 sq. in. to 17 plus sq. in., this being in proportion to the characteristics and physical properties of the material.

Rule 4

The committee recommends that Paragraph (1) of Section (h) of this rule be modified as follows:

Proposed Form—(h) (1) Tank cars. Sheets, heads or domes of non-insulated cars, when bent inwardly in excess of 8 in. by 8 in., or equivalent area, or when bent inwardly in excess of ¼ in. in depth regardless of area; *however, dents in heads due to present or former head-block anchorage, will be owner's responsibility.*

Rule 5

The committee recommends that the extended time limits of second paragraph of this rule, as shown in the 1936 Code, be continued until January 1, 1938, because the curtailment in car repairs results in holding of bad-order cars under present conditions.

Rule 17

The committee recommends that the "remarks" column reference to items 26, 28 and 30 appearing in the Knuckle Table in Paragraph (2) of Section (c) of this rule be modified in the next supplement to make clear that no charge is to be made for the knuckles in these items if applied to Type E couplers and that, if the knuckles removed as specified in these items are in good condition, secondhand credit must be allowed.

The committee recommends that a new section (j) be added to this rule, effective August 1, 1936, as follows:

Proposed Form—(j) ***In the application of brake-beam hangers, a difference in length of ⅜ in. (plus or minus) from that standard to car, will be considered as proper repairs.***

Rule 18

The committee recommends the addition of a new last paragraph to this rule, with new Fig. D, as follows:

In the application of secondhand couplers complete, or secondhand coupler bodies, the shank shall not be less than 21 in. in length from striking horn to crest of worn surface of butt, nor less than 3⅞ in. from pulling (rear) surface of horizontal key slot to crest of worn surface of butt, established with parallel straight edges; otherwise, such body shall be charged at scrap value. (See Fig. D following). Coupler bodies having such minimum dimensions shall not be removed from cars for these defects alone, but if removed for other reasons and are otherwise in serviceable condition same shall be credited at secondhand value, with no allowance for expense of reclamation.

Rule 19

The committee recommends that ninth item listed under this rule, covering material that must not be used in making repairs to foreign cars, be modified in the next supplement as follows:

Proposed Form—Plain cast-iron brake shoes must not be used. New reinforced-back brake shoes must be used to justify bill. *Effective January 1, 1937 new reinforced-back brake shoes meeting requirements of A.A.R. Specification adopted in 1935 must be used to justify bill.*

Rule 20

The committee recommends that second paragraph of this rule be modified as follows:

Proposed Form—When construction of car and trucks precludes the common methods of adjusting coupler heights, the application of metal shims between journal boxes and arch bars or truck sides, *or the riveting or welding of metal shim to coupler carrier iron, is permissible.*

Rule 45

The committee recommends that this rule be modified so that instead of applying to center sills bent between bolsters, it will apply to *one or both metal center sills broken between bolsters* as well as to *one or both center sills* bent between bolsters; and to make it clear that handling-line responsibility applies to bent sills only if subsequently broken under the provisions of Rule 32.

Rule 49

The committee recommends that last sentence of Paragraph (a) of this rule be modified and included in the next supplement, as follows:

Proposed Form—Where receptacle is used, same should be in accordance with A.A.R. Recommended Practice specification. applied one per car, preferably located as follows, *or at other location conveniently accessible,* but in no case more than 5 ft. 6 in. from top of rail.

Rule 62

The committee recommends that second paragraph of this rule be modified in the next supplement, as follows:

Proposed Form—No charge shall be made for application of separate common nuts unless such nuts are fully tightened, and, where applied to journal-box bolts, column bolts or brake-hanger bolts, such common nuts must be secured with nut lock or lock nut.

Note—It will be understood that the above provision also applies when such bolts are renewed.

Rule 66

The committee recommends that Section (g) of this rule be modified to show that the conditions of the section apply when repacking is due to change of *one or more pair of wheels in each truck,* because present wording is being misconstrued to mean that all wheels must be changed to justify the one-half-hour labor charge.

Rule 70

The committee recommends that Section (c) of this rule be modified, effective August 1, 1936, as follows:

Proposed Form—(c) A.A.R. double-plate shall not be substituted for A.A.R. single-plate cast-iron wheels. *For the purpose of this rule a single-plate wheel and a double-plate wheel mounted on same axle shall be considered as a pair of double-*

plate wheels, and charged and credited accordingly. Defect card is not required for such improper substitution of wheels. (See Rule 98, Section (c-5), for charges and credits).

This change is to discourage the substitution of such mixed wheels in place of single-plate wheels, in repairs to foreign cars.

Rule 87

The committee recommends that the extended time limit of first paragraph of this rule, as shown in the 1936 Code, be continued to January 1, 1938.

Rule 91

The committee recommends that the second paragraph of Section (b) and the last sentence of Section (c) be modified to permit 60 days within which countercharge authority may be issued, for the reason that the rule should give as much time to answer exceptions as it does to take exceptions to a bill.

Rule 92

The committee recommends that a new last paragraph be added to this rule, to read as follows:

In the case of leased cars, upon request by owner, such cars shall be grouped by initials and consolidated in same monthly bill with cars bearing owner's name or initials. However, separate statement and totals for each such group need not be furnished.

There is no objection to rendering bill in this manner, if so requested by car owner. However, separate statements and totals constitute additional work which should not reasonably be imposed upon repairing line.

Rule 94

The committee recommends that the extended time limits of first paragraph of this rule, as shown in the 1936 Code, be continued until January 1, 1938.

Rule 98

The committee recommends that a new note be added following Section (g) of this rule, to read as follows:

Note—In the predetermination of service metal on wrought-steel wheels by use of the standard wrought-steel wheel gage, when neither wheel is scrap, the amount of metal required to be turned off the wheel suffering the greater amount of loss, should apply equally to the mate wheel.

Rule 104

The committee recommends that Section (a) of this rule be modified as follows:

Proposed Form—(a). Secondhand A.A.R. Type D, Type E, swivel shank couplers and couplers having radial butt, or parts of same, shall be charged and credited at 75 per cent of value new. Credit shall be allowed for all parts of such couplers. *Secondhand cast-steel coupler yokes of 24⅝-in. pocket spacing and secondhand two key forged coupler yokes, when both types are designed for 1½-in. by 6-in. horizontal cross keys, shall be charged and credited at 75 per cent of value new.*

The committee recommends that the following items be added to Section (1) of this rule, to be charged at 50 per cent of gross value new, less credit for part removed, when applied, secondhand, in repairs to owner's defects or on authority of defect card:

Air-brake parts as follows:

Auxiliary reservoir, detachable type (Nos. 2445, 24446), per Item 8, Rule 101.

Auxiliary reservoir, combined type (Nos. 2439, 21838), per Item 9, Rule 101.

Cylinder body, detachable or combined type (Nos. 67928, 68462), per Item 19, Rule 101.

Cylinder, complete, detachable type (with cylinder piston packing), Nos. 69817, 69751, per Item 19-B, Rule 101.

Cylinder and reservoir, complete, combined type (with cylinder piston packing), Nos. 69816, 69818, per Item 19-C, Rule 101.

Triple valve body, complete, old style, W. A. B., per Item 52, Rule 101.

Triple valve body, K1 and K2 types, per Item 54, Rule 101.

Triple valve, complete, convertible type, per Item 56, Rule 101.

Triple valve, complete K1 or K2 Standard, per Item 57, Rule 101.

Coupler yokes, except as provided in Section (a).

Draft arms.

Draft lugs.

Draft springs, other than those used in connection with friction draft gears.

Metal roofing, including caps.

Truck-spring caps, pressed steel. (This includes bottom caps, often designated as truck-spring seats.)

Passenger-Car Rules

Rule 4

The committee recommends that the effective date of second paragraph of this rule, with reference to equipping all steel or steel underframe cars with cardboards or suitable receptacle for the accommodation of defect and joint evidence cards, now set at January 1, 1937, be extended to January 1, 1938.

Rule 7

The committee recommends that a new Paragraph (3) be added to Section (h) of this rule, to read as follows:

(h) (3) In the application of secondhand couplers complete, or secondhand coupler bodies, the shank shall not be less than 21 in. in length from striking horn to crest of worn surface of butt, nor less than 3⅞ in. from pulling (rear) surface of horizontal key slot to crest of worn surface of butt, established with parallel straight edges; otherwise, such body shall be charged at scrap value. (See Fig. D of Freight Rule 18.) Coupler bodies having such minimum dimensions shall not be removed from cars for these defects alone, but if removed for other reasons and are otherwise in serviceable condition same shall be credited at secondhand value, with no allowance for expense of reclamation.

The committee recommends the addition of a new Section (m) to this rule, to read as follows:

(m) Refrigerator cars, designed and constructed for passenger-train service, must be reweighed and restenciled only by owners or their authorized representatives.

Rule 8

The committee recommends that a new Item 16 be added to Section (a) of this rule covering delivering line defects, to read as follows:

(16) Failure to uncouple steam hose or metallic steam connectors when uncoupling cars.

Rule 9

The committee recommends that Section (e) of this rule be modified by substituting for the words *cleaning and steaming when performed periodically* the words *periodic sanitary cleaning.*

Rule 21

The committee recommends that Item (17) of this rule be modified by substituting for the words *cleaning and steaming* the words *periodic sanitary cleaning.*

The report was signed by: W. H. Flynn (chairman), general superintendent motive power and rolling stock, N.Y.C.; C. T. Ripley (vice-chairman), chief mechanical engineer, A.T.&S.F.; T. W. Demarest, general superintendent motive power, Penna.; T. Beaghen, Jr., superintendent car maintenance, Mexican Petroleum Corporation; J. J. Hennessey, assistant superintendent car department, C.M.St.P.&P.; L. Richardson, mechanical assistant to vice-president and general manager, B.&M.; G. E. McCoy, assistant general superintendent car equipment, Can. Natl.; M. F. Covert, general superintendent of equipment, refrigerator car division, General American Tank Car Corporation.

In the presentation of this report the committee proposed certain supplementary recommendations to Rules 3 and 36, covering the use of advertising on refrigerator cars and the use of the shipper's name and location on commodity and unloading cards, the latter being beneficial and permissible. The committee said, however, that the use of printing on red background should be confined exclusively to cards used in connection with explosive and other dangerous articles as required by the Interstate Commerce Commission regulations.

Action.—The report was adopted.

Economies in Cost of Billing for Foreign Freight-Car Repairs*

As instructed, your committee has made investigation of the cost of billing for foreign freight-car repairs, has considered the economies of handling this billing through a central clearing bureau, or regional clearing bureaus, as well as the matter of discontinuing billing for foreign freight-car repairs between railroads and discontinuing such billing entirely for all foreign freight-car repairs.

Central or Regional Clearing Bureaus

The survey made on the performance of December, 1932, in-

* This is a summary of the September, 1935, report of the sub-committee referred to as Exhibit B of the report of the Arbitration Committee.

dicated that the establishment of a central billing bureau would bring about immediate economies amounting to approximately $15,000 per year, and that these economies would eventually be increased to approximately $60,000 per year.

The survey made on the performance of December, 1934, indicates that the establishment of a central billing bureau at the present time would show a payroll loss at first of approximately $46,000 and that eventually this loss would be converted into a saving of $3,000 per year.

This difference is brought about by decreased costs reported in handling the billing, due to increased efficiency, improved methods and economies effected since the promulgation of the 1932 report and the adoption of recommendations contained therein.

The cost of preparing outgoing bills for December, 1934, fluctuated from $16.96 to $111.64 per $1,000 billed, the general weighted average being $30.77; and costs of checking and handling incoming bills varied from $4.51 to $35.07 per $1,000 paid, the general weighted average being $11.23. The committee feels it is probable that further economies could be effected by roads showing a high cost of billing.

From the foregoing it will be obvious that there is no economy in the establishment of a central billing bureau. On the other hand, such an organization would have some distinct disadvantages:

1—Car owner would have no means of:

(a) Locating responsibility for wrong repairs made to his equipment.
(b) Detecting roads making a practice of specializing in certain items of repairs, which may be done only by analysis of bills.
(c) Checking for guaranteed wheels and other guaranteed parts removed from his equipment on foreign lines.
(d) Checking items of repairs for so-called duplicate and time limit charges, such as renewal of journal bearings, periodic repacking of journal boxes, cleaning of air brakes, renewal of wheels and relightweighing of equipment.
(e) Checking car repair bills with the correspondence in cases of cars reported to owner for disposition under Rule 120 (owner's defects), extensively damaged cars sent home on defect cards, wreck truck applications, fire damage insurance reports or claims, and material ordered from car owner under Rule 122. All these features are directly associated with car repair billing.
(f) Checking, investigating and controlling practices at own shops through studies of accumulated billing repair cards, covering extent and character of repairs made to foreign cars and, also, the studying of charges rendered where complaints from car owners may be received as to cost of repairs billed per car day, or per one thousand miles operated.
(g) Checking cost of maintenance and/or failures of certain devices on system cars, such as certain types of roofs, doors, coupler attachments, draft gears, auto loading devices, wheels, etc.

2—The impracticability of the central billing bureau checking accident reports of individual railroads for the purpose of preventing unfair usage items being billed against car owner.

Elimination of All Billing for Freight-Car Repair

The committee has considered a deduction from the per diem and mileage rate allowances, in order to eliminate all billing. This would effect a saving of $619,680 per year. Dividing this amount among the 2,500,000 freight cars owned by railroads and private lines, the average cost of billing would be approximately 25 cents per car per year.

Offsetting the above expense, elimination of billing for repairs to foreign freight cars would have the following distinct disadvantages:

1—Although car users would, to compensate for expense of repairs to foreign cars, retain a portion of the per diem and mileage allowances therefor, unless a method were devised to check expenditures of individual roads, the urge of the user to conserve as much as possible of the said allowances would undoubtedly lead to his neglecting to perform his fair share of foreign freight-car maintenance to the detriment of such equipment.

2—This neglect of repairs to foreign cars would first become apparent at interchange points and result in a general tightening up of inspection. That, in turn, would retard the movement of cars in interchange, and to properly protect receiving lines against the delivery of under-maintained cars, it would, without question, be necessary to substantially increase the force of inspectors at interchange points.

3—The same urge by car owners (including private car lines) to neglect repairs to their own cars about to be delivered in interchange, would assert itself.

4—This incentive to neglect repairs to loaded cars would increase transfers, switching expense, detention enroute and consequent damage claims.

5—Car owners would have no means of checking responsibility for failure of repairing line to maintain owner's standards and A. A. R. requirements.

6—The use of inferior material in repairing foreign cars, would result in more frequent shopping of cars, increased maintenance, failure of cars enroute and, consequently, increase in train detentions.

7—Switching and terminal lines which do not participate in per diem or the mileage rates would have no means of clearing their car repair expense.

8—Difficulty in arranging settlement for destroyed cars, or for extensively damaged cars which handling line may desire to return to owner on account of not having proper material or facilities to make repairs, or for other reasons.

9—Study was made of one member road during the month of March, 1935, as to cost of repairs per car, per day, spent on foreign cars of fifty different ownerships. Likewise, the cost per car, per day, spent on same fifty railroads to this member's cars while on their lines. Also, the amount expended by the same member railroad per car, per mile, on repairs to cars belonging to thirty private lines. The cost of repairs to the cars of the fifty different ownerships ranged from $.3536 to $.0379 per car, per day. In the case of the thirty private lines, from $.00623 to $.00078 per car, per mile. Conversely, the cost of repairs to this member's cars on the fifty foreign lines, ranged from $1.375 to $.0314 per car, per day. These are wide variations and it must be obvious that unless there were inaugurated and made effective, some system whereby each individual railroad would be obliged to assume its fair proportion of foreign car repairs, the retention of an allowance from the per diem and mileage rates for this purpose would react to the benefit of some roads and to the detriment of others. In other words, such an arrangement would be grossly inequitable.

In order to take care of the disadvantages enumerated above, it would be necessary to provide new or revised methods and rules to govern the condition of and repairs to freight cars for the interchange of traffic, involving additional expense, in the treatment of which three important considerations were kept in mind: First, the interchange of cars must be in accordance with the safety appliance law. Second, the elimination of this billing must in no way affect the physical condition of cars interchanged from a safety standpoint. Third, the movement of cars in interchange must not be slowed up.

Summary of Additional Expenses

Summarizing the estimates to remedy, as far as practicable, the nine major disadvantages listed, we have the following additional expenses:

Disadvantages 1, 2, 3, 8 and 9		$565,553.60 per year
Disadvantage 4—		
Transferring loads (minimum)	$1,250,000.00	
Loss and damage (minimum)	100,000.00	
		1,350,000.00 per year
Disadvantage 5—No estimate.		
Disadvantage 6—No estimate.		
Disadvantage 7—Clerical force for switching and terminal lines		21,707.00 per year
		$1,937,260.60 per year

It is probable that the additional expenses due to Disadvantages 5 and 6 would increase the above total to at least $2,000,000 per year. The committee feels that these estimates of additional expenditures which the elimination of billing would necessitate, are conservative.

Elimination of Billing for Repairs to Foreign Freight Cars as Between Railroads Only

According to the survey made of the December, 1934, performance, 33.9 per cent of the total bills rendered was for private line accounts ($2,119,748.66 total, $718,748.18 for bills against private cars). 33.9 per cent of $36,339, which is the total saving per month for bills rendered if all billing were eliminated, is $12,318.92. Also with reference to incoming bills: 2.79 per cent of the total bills received was for private line accounts ($1,551,242.49 total, $43,299.34 for bills against private cars). 2.79 per cent of $13,233.65, which is the total saving per month for bills received if all billing were eliminated, is $369.22. Then $12,318.92 plus $369.22 equals $12,688.14, the total amount of saving by billing elimination, attributable to private cars, on the theory that the cost of billing as between privately owned cars and railroad owned cars is directly proportional to the amount of the bills.

As this calculation is based upon 96 per cent of the car ownership, 100 per cent would be $12,688.14 times $\frac{100}{96}$ equals $13,216.81 per month or $158,601.72 per year.

Then $619,680.00 (total savings per year by all billing elimination) minus $158,601.72, equals $461,078.28 the savings per year if billing for railroad owned cars only were eliminated. This is 74.4 per cent of the total of $619,680. On the assumption that the cost of the major disadvantages, $2,000,000 per annum, are apportioned on this same basis, then if billing between railroads only were eliminated, these major disadvantages would cost 74.4 per cent of $2,000,000 or $1,488,000 to produce the saving of $461,078.28.

Conclusions and Recommendations

In view of the fact that but $461,078.28 per year would be saved by eliminating billing between railroads, as compared with the minimum additional expense of $1,488,000 per year which would be necessary, and, furthermore, that but $619,680 per year would be saved by all billing elimination, as compared with the minimum annual additional expense of $2,000,000, it is the recommendation of your committee that billing for foreign freight-car repairs be continued.

The members of the Subcommittee on Economies in Connection with Cost of Billing for Foreign Freight Car Repairs, which prepared this report are: W. R. McMunn, chairman; J. E. O'Brien; J. E. Mehan; C. J. Hayes and T. J. Boring.

Couplers and Draft Gears

Draft Gears

Approval Tests.—No additional certificates of approval have been granted during the past year. An application has been received for approval of a new type of gear, specimens of which have been obtained and are undergoing tests in the A. A. R. laboratory at Purdue University. The total number of certified gears, therefore, is still nine, as listed in the latest issue of the Code of Interchange Rules.

Other Laboratory Work.—The testing laboratory has been engaged on a wide variety of work, including periodic check tests of non-harmonic springs and special trucks for the Car Construction Committee, tests designed to establish a basis for improvement in specification requirements for draft gears, and commercial tests of draft gears and springs.

Obsolete Gears.—The sub-committee is continuing to co-operate with the Committee on Prices for Labor and Materials in an effort to relegate to the obsolete class as rapidly as practicable the older and less efficient types of gears.

Standard Draft Gear.—This subject has received continued consideration. For the reasons set forth in last year's report, one standard draft gear is considered desirable but not essential, especially at this stage of development. It is probable, however, that within the next year the subcommittee will recommend adoption of requirements providing for complete physical interchangeability of approved freight car draft gears, including standardization of supports and guides for the gear.

Application of Non-Approved Gears.—It was found that one car owner was applying a non-approved type of draft gear to a lot of new cars. The secretary of the Association called the attention of the owner to Par. (1), Sec. (d) of Interchange Rule 3, which requires the application of certified gears, and the road promptly discontinued further applications and arranged to remove all the non-approved gears already applied and substitute certified gears.

Marking of Certified Gears.—A misunderstanding has arisen with respect to the proper marking of certified gears. All certificates of approval now in force have been issued under the 1931 specifications and, for this reason, most manufacturers have continued to mark their gears "A. A. R.-31," notwithstanding the fact that the present standard specifications are dated 1934. One manufacturer, however, changed the marking on his certified gear to "A. A. R.-34," when the new specifications were issued. The sub-committee has decided, inasmuch as the present specifications are dated 1934, all certified gears should be so marked. In the future, whenever changes are made in the specifications so as to require a new printing, with a corresponding change in date, the sub-committee will advise the secretary whether or not the change will necessitate any action on the part of the manufacturers of approved gears other than to change the marking. The secretary, in turn, will notify the manufacturers so that the marking at all times will agree with the latest issue of the specifications.

Revision of Specifications.—It is recommended that the present Standard Specifications for Approved Draft Gears for Freight Service, M-901-34, be revised as follows:

(a) Change Par. 11, Appendix A, to read:

"11. If a manufacturer desires to make any change in a draft gear he is marketing under a certificate of approval, he shall advise the secretary of the Mechanical Division, furnishing full information as to the nature of the proposed change and the objects expected to be accomplished thereby. This provision is intended to cover such changes as methods of assembling parts, methods of gaging parts or assemblies, methods of conditioning assembled gears, changes in metallurgy or physical characteristics of parts, and changes in design of parts, regardless of whether the adoption of these changes would result in changes in the drawings or specifications covering the parts or assemblies. If a new issue of a drawing or specification is made for the purpose of clarifying or correcting it, notice shall also be given to the secretary. The Draft Gear Committee will decide in each case what action is to be taken on these changes and, in the event they are approved, will arrange to have the records accompanying the certificate of approval changed so that these will be up-to-date at all times."

The purpose of this change is to clarify the present wording, which apparently has been misunderstood by some manufacturers.

(b) Change Par. 13, Appendix A, to read:

"13. On or before January 5th of each year the secretary of the Mechanical Division will canvass the manufacturers of approved draft gears to determine whether the record drawings and specifications of each approved draft gear are up-to-date. For the benefit of members of the Association of American Railroads a separate list of approved gears will be shown in the Interchange Rules."

Adoption of this change will place the regulations in line with what experience has shown to be the best method of handling these details. For convenience in making the yearly canvass, a form of questionnaire will be prepared for submission to each manufacturer.

(c) Add new Par. 16, to Appendix A, to read:

"16. When a certificate of approval is issued for a draft gear for which the committee does not have any previous record of service performance, this certificate shall be conditional until the service performance of the gear shall have been investigated. In order to facilitate this investigation, the manufacturers shall notify the secretary of the Mechanical Division of all sales of the gear during the period while the certificate is conditional. The Draft Gear Committee will arrange to supervise the original installation of a limited number of these gears and, after the expiration of a two-year service period, their condition will be checked in order to determine whether the conditional restrictions on the certificate may be removed."

Adoption of paragraph is recommended in order to make a distinction between gears known to give satisfactory performance and gears of an entirely new type which have no service record. Indications are that there will be no more applications for approval of service-tried gears, but that there will be applications for approval of new types of gears.

The sub-committee report on draft gears was signed by H. W. Faus, chairman; H. W. Coddington, H. I. Garcelon, L. H. Schlatter and W. Bohnstengel.

Type E Couplers

Methods Followed in Maintaining Quality and Interchangeability.—The Type E coupler has been in service long enough to obtain some service experience with it. In this connection it should be of interest to describe briefly the methods followed in order to maintain uniform high quality and strict interchangeability. The Mechanical Committee of the Coupler Manufacturers arranges with each manufacturer, two or three times each year, to submit for checking a complete coupler representing the current average production.

Each group of representative couplers submitted is inspected and completely gaged. This is followed by an interchange of knuckles, where each manufacturer's knuckle is applied and operated in all couplers. Next follows a miscellaneous interchange of parts with no two parts of the same manufacture in any one bar.

Results are tabulated on prepared forms, analyzed by each manufacturer and any adjustments made which may seem necessary.

Each group of couplers is then subjected to a physical test, usually a static tensile test or a dynamic compression (strike) test. These results are also tabulated.

This practice of periodic inspection and testing of couplers

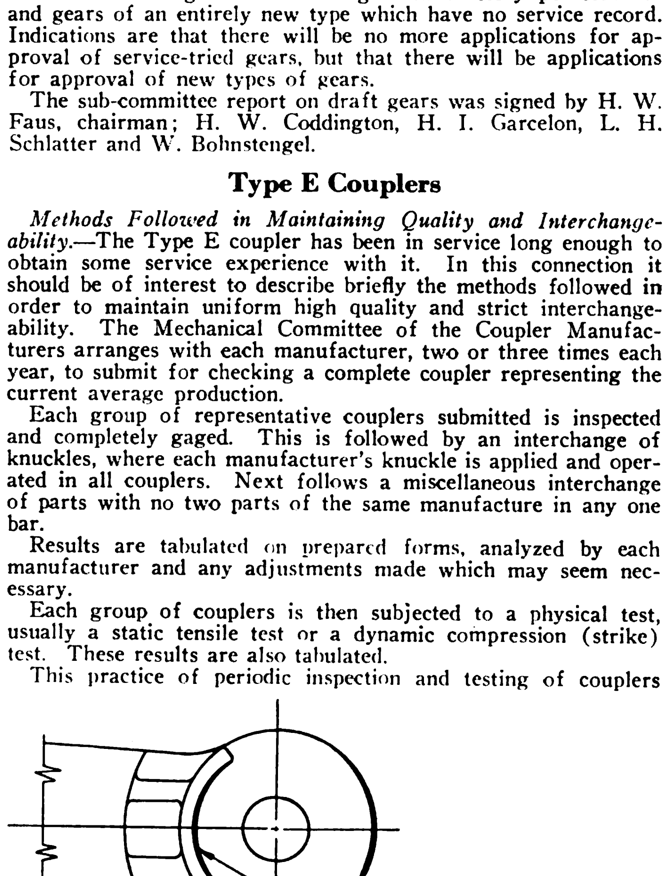


Fig. 1—Proposed method of reclaiming worn A.A.R. Standard E and Type D coupler swivel shanks

was instituted soon after the Type D coupler was adopted in 1916, and has been continued ever since.

Since adoption of the Type E coupler in 1931, there have been five groups of representative couplers submitted to the Mechanical Committee of the Coupler Manufacturers. Four groups were subjected to static tensile tests and one to a dynamic compression (strike) test. In one of the tensile test groups the couplers were provided with alternate standard swivel shanks and included representative swivel yokes. The couplers in all other groups were provided with standard rigid shanks.

[Tables giving test results which were included in the report have been omitted.—EDITOR.]

Top-Lock-Lifter Hole Caps—Application.—Some roads have reported that the cap used to close the top-lock-lifter hole in Type E bottom-operated couplers did not effectively close this opening. Investigation developed this to be due to workmen having failed to apply the cap in the proper manner. The cap has a convex surface which must be flattened down with a hammer in order to spread the inside nibs against the side of the lock lifter hole. If this practice is observed there should be no occasion for complaint about the caps not effectively closing the opening.

Bottom Rotary Lever.—It has been observed in the operation of some earlier Type E bottom-operated couplers that the rotary lever would, in the process of rotating, cant in such a manner as to produce abnormal friction between the lever and the surface upon or against which it rotates. This has been corrected and a new design presented for approval. This improvement has been approved by the Coupler Committee and bottom-operated type E couplers now produced have this new rotary lever.

Inspection and Maintenance of Draft Gears

In 1934, the committee presented a recommended practice for inspection and maintenance of draft gears and attachments by car owners. These recommendations were adopted and a number of roads have been conforming to this method which has resulted in a marked improvement in reducing free slack. The process on some other lines has not been followed so closely and the committee is urgently stressing the importance of all roads complying with this method of reducing unresisted slack. It has been suggested that observance of this recommended practice be made mandatory and at the same time provide for the attention being given on other than owned cars and setting up of interchange price for the operation. The committee is hoping to avoid such an alternative and, therefore, is urging the membership to institute the practice of reducing unresisted slack in draft gears and attachments as recommended, and shown on page 141, Sec. L of the Manual.

Type D Coupler Bodies—Discontinuing Use

In 1935 attention was directed to the action taken by the Association authorizing coupler manufacturers to dispose of patterns, core boxes, etc., relating to the production of Type D coupler bodies.

In order to protect in interchange the interest of roads using the standard E coupler, the committee recommended that the Arbitration Committee revise Rule 101 so that after January 1, 1936, a new Type D coupler body can only be applied to a foreign car at second-hand value. This rule has been effective since the first of the year, but the record of coupler sales indicate that it has not had any retarding influence upon the demand and production of Type D couplers in some territories. It is, therefore, recommended that Interchange Rule 3 be revised to read as follows:

"(c-10) Coupler, Type D, cast after August 1, 1936, prohibited, effective January 1, 1937, on all cars. In interchange."

Reclamation of Swivel-Shank Couplers

Consideration has been given to methods to be recommended in the reclamation of swivel-shank couplers to compensate for wear between buffing surfaces. This study has involved the inspection of a large number of swivel-shank couplers removed from service. A limited number of swivel-butt castings and

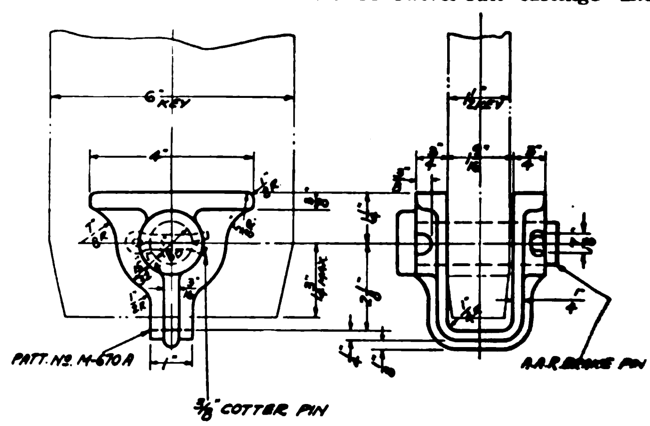


Fig. 3—Permissible substitute—Universal draft-key retainer—Universal Draft Gear Attachment Company

swivel pins have also been inspected, but no vertical-plane yokes were available for this study. Consideration has also been given to inspections made of swivel-shank couplers, swivel-butt castings, vertical-plane swivel yokes and swivel pins still in service. As a result the committee recommends that the following practices be observed in the reclamation of swivel-shank couplers:

1. A.A.R. standard E and Type-D couplers having swivel shanks be

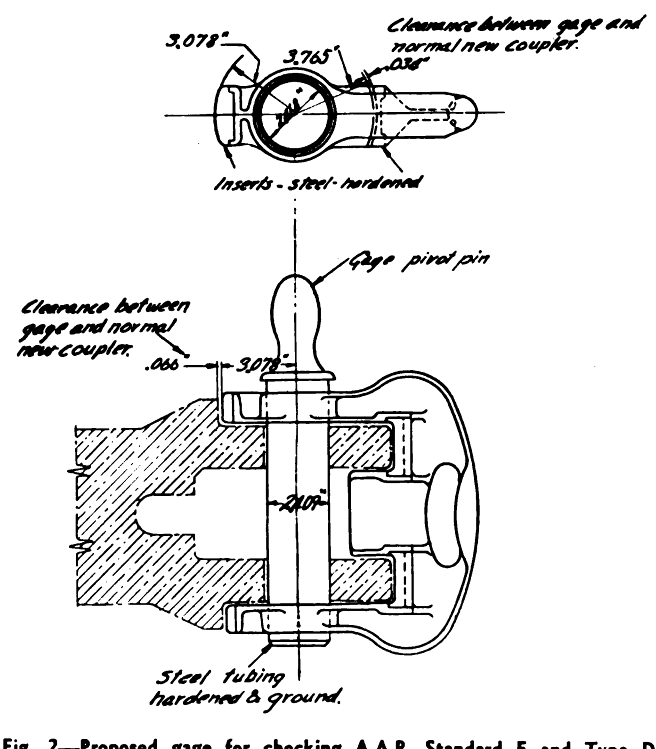


Fig. 2—Proposed gage for checking A.A.R. Standard E and Type D coupler swivel shanks after reclamation

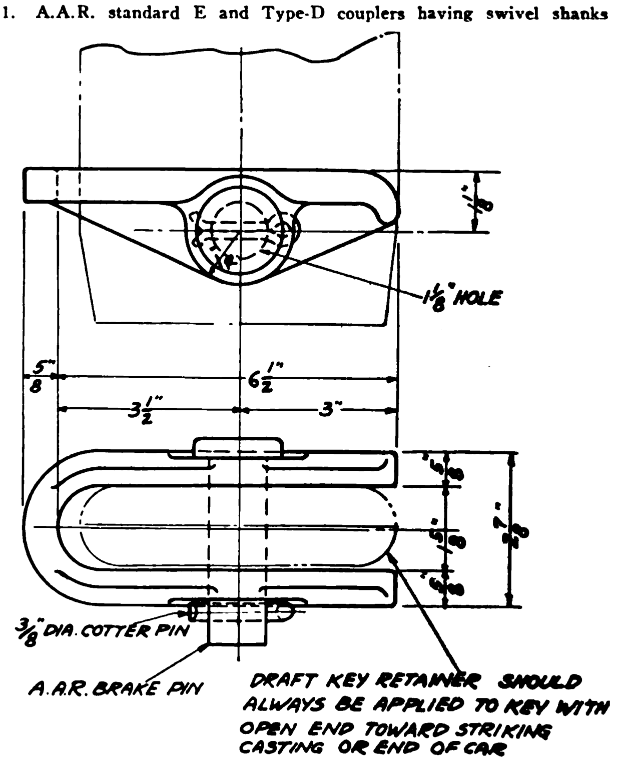


Fig. 4—Permissible substitute—Surelox draft-key retainer—Western Railway Equipment Company

subject to reclamation when the free slack in the swivel joint has increased to ⅜ in.

2. Reclamation of swivel-shank couplers as covered in Item 1 be accomplished by building up, by electric or acetylene welding, the ends of the shank loops and the top and bottom front buffing shoulders of the shank an amount equal to a new coupler maximum size. Fig. 1 shows the locations where this building up process is recommended, and Fig. 2 the general design and important gaging dimensions of a suitable gage recommended for this reclamation purpose.

3. Coupler bodies that have been reclaimed in accordance with Item 2 must be re-annealed before being returned to service.

4. The difficulty of satisfactorily performing any reclamation operations on swivel pins, swivel-butt castings and swivel yokes, so far as the swiveling feature is concerned, indicates that it will be better to replace these items with new parts when too badly worn for further service.

This subject is to be given further consideration with the idea of keeping abreast of developments that might affect the reclamation practices above recommended.

Tight-Lock Couplers

Considerable interest has been expressed by roads anticipating modern passenger car construction with reference to tight-lock couplers. The coupler manufacturers have been doing some individual development along this line and your committee has requested them to give this subject their joint consideration toward finally recommending a reduced-contour-clearance coupler

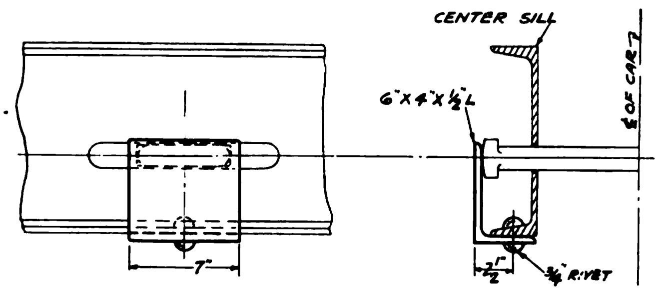


Fig. 5—Permissible substitute draft key retainer—N. & W.

or a tight-lock coupler embodying those features of design that may be necessary to provide the simplest and best arrangement of one such coupler development. A sub-committee is working with the manufacturers in connection with the development of the tight-lock coupler and it is anticipated that a design that will meet requirements will soon be presented.

Draft Key Retainer—A. A. R. Standard Approved Equivalent

Interchange Rule 3—Item 3, reads as follows:

"(3) Draft Key Retainer, A.A.R. Standard, or approved equivalent, or A.A.R. Alternate Standard one-inch diameter hair-pin type, required on all cars (equipped with horizontal draft keys) built new or rebuilt on or after March 1, 1929. Effective January 1, 1937, the foregoing requirement will also apply to all cars built prior to March 1, 1929. From owners."

Your committee has been asked to emphasize the importance of providing proper draft key retainers on account of several serious accidents having occurred due to couplers pulling out after losing the draft key as a result of non-standard draft key retaining devices. There are two types of standard draft key retaining devices shown in the Manual. The T-pin type is shown on Plate C-28-B, and 1-in. hair pin type on Plate C-28-C.

There have also been recognized as permissible substitutes for the two standard retainers the three devices shown in Figs. 3, 4 and 5.

With these various inexpensive devices available for application, and as a safeguard against accidents that have occurred where standard devices were not used, your committee recommends that the date for all cars offered in interchange to be so equipped be not extended beyond the present published date of January 1, 1937.

The report was signed by R. L. Kleine (chairman), assistant chief motive power, Penna.; H. W. Coddington (vice-chairman), engineer of tests, N. & W.; C. P. Van Gundy, engineer of tests, B. & O.; C. J. Scudder, superintendent motive power and equipment, D., L. & W.; Samuel Lynn, superintendent rolling stock, P. & L. E.; L. P. Michael, chief mechanical engineer, C. & N. W.; C. T. Ripley, chief mechanical engineer, A., T. & S. F.

In presenting the section of the report on couplers, the committee added a recommendation for the modification of the top lock lifter on the Type D couplers to extend the anti-creep shoulder and suggested that the modified lifter be known as the Number 3 type. It further recommended that the Number 2 lifters have the anti-creep shoulder extended by application of welding, so that it may conform to the Number 3. This is to overcome the uncoupling in service, presumably due to the anti-creep feature of the top lock lifter not preventing the upward creeping of the lock. Sketches of the lock lifters and gages suitable for governing these changes in them will be included in the supplement attached to the letter ballot on the report.

Action.—The report was accepted and the recommendations referred to letter ballot.

Car Construction

The report of the Committee on Car Construction covered a variety of subjects, many of which had been assigned to sub-committees. For certain portions of the report, particularly where progress only was recorded, this abstract has been limited to a concise summary of the committee's work and its suggestions accompanying the report as Appendix A covering alternate designs for standard hopper cars.

Designs of Standard Cars

The report last year outlined the fundamental principles of the program submitted to and approved by the Mechanical Division in 1932, under which your committee since has been co-operating with the Design Committee of the American Railway Car Institute on production of designs for the principal types of freight equipment cars which represented the latest state of the art for weight, cost, construction, strength and general utility, in order that any road might adopt these designs and construct thereto their cars of the types produced.

These designs necessarily are based on the use of non-experimental materials and methods of construction. Further progress in the direction of light-weight alloy steel designs is not interfered with or retarded, however, because the fundamental characteristics thus established may be effectively and advantageously utilized thereon, this being exemplified by the fact that various builders have proceeded accordingly on new designs of light-weight alloy steel cars which have been constructed for test or interchange service.

It seems necessary, however, to repeat the following paragraph from the 1935 report:

Whether or not full advantages are to be derived from progressive standardization of freight equipment depends largely, if not almost entirely, on the attitude and the position taken from this time on by the A. A. R. in the matter of building the standard designs or the still lighter weight units in high-tensile steels or other materials based thereon when cars of these types are required.

It is not our purpose again to discuss the advantages of freight-car standardization or the soundness of the 1932 program, first, because this is a subject which all member roads now should be thoroughly familiar with, and second, for the reason that the efficiency and the economic value of the standard steel-sheathed wood-lined box car from the standpoints of "weight, cost, construction, strength and general utility" have been proved through extensometer, deflectometer and impact tests and finally, by the severe service test on the C. & O. to an extent never before undertaken or approached. It is a significant fact, however, that this steel-sheathed design is the first car to be adopted as Standard by the present A. A. R. or any of its predecessors.

Some member roads not only have supported the standard car principle by voting in the affirmative on the designs presented but have taken advantage of this work by ordering thereto new cars constructed. On the other hand, certain roads have proceeded independently as in the past, while in other cases those requiring new cars have incorporated in their own designs certain A. A. R. features such as the new standard center-sill section, bolster center filler casting, truck center-plate height and hopper and door construction, thus giving practical recognition to the fact that at least these features are preferred to their own.

In order to present an up-to-date picture of the situation with reference to the extent to which the A. A. R. standard designs have been utilized, or if preferred, the extent to which non-standard cars have been built, and keeping in mind the fact that the box car was submitted in 1932 and the 50- and 70-ton hoppers in 1935, the following summary is given, which, although not complete in all details, is substantially correct.

(Note: Summary of standard designs appears on page 294—Editor.)

It is not the function of your committee to promote or defend a procedure advocated by the A. A. R. executives and approved by the Mechanical Division other than to carry out instructions, and we now say that through the skill and co-operation of the A. R. C. I. Design Committee and the efforts of the Car Construction Committee, to date this has been done. The regular work of your committee, however, is becoming more voluminous, diversified and difficult, largely because of the extended activities of the new A. A. R., together with the period of transition and rapid change through which the railroad transportation industry now is passing. It appears, therefore, that we might better devote all available time and energy to current problems exclu-

Extent to Which Standard Designs Have Been Utilized

Item	Design	No. of cars
	Box and Auto Box Ordered During 1934	
1—A. A. R. throughout		1,750
2—A. A. R. except former standard center sill, but with the 25¾-in. center-plate height		1,550
3—Former A. A. R. tentative design		250
4—Not A. A. R.		6,252
5—Miscellaneous and not investigated		12
Total		9,814
	Hopper Cars Ordered During 1934	
6—Conforming closely to A. A. R. standard then in process of design		8,500
7—Light-weight alloy steel to basic A. A. R. then being designed		110
8—Not A. A. R.		1,665
9—Miscellaneous and not investigated		12
Total		10,287
	Box and Auto Box Ordered During 1935	
10—A. A. R. throughout		1,255
11—Not A. A. R. except center sill section and 25¾-in. truck height		510
12—A. A. R. basic design, alloy steel, light weight		2
13—Not A. A. R.		8,305
Total		10,072
	Hopper Cars Ordered During 1935	
14—A. A. R. throughout		5,100
15—A. A. R. basic design, alloy steel, light weight		16
16—A. A. R. except outside stakes and height of side		475
17—Not A. A. R.		470
18—Miscellaneous and not investigated		3
Total		6,064
	Box and Auto Box Ordered as of April 1, 1936	
19—A. A. R. throughout		300
20—A. A. R. throughout (inquiries released but orders not placed as of April 1)		1,300
21—A. A. R. except underframe with floating center sill		500
22—Not A. A. R. except center-sill section and 25¾-in. truck height		500
Total		2,600
	Hopper Cars Ordered as of April 1, 1936	
23—A. A. R. except pressed U side posts instead of Z bar		2,000
24—Not A. A. R. except center-sill section, bolster center filler, 25¾-in. center-plate height and unit hoppers		1,000
25—Not A. A. R.		50
Total		3,050
	Freight Refrigerator Cars	
26—Steel-sheathed following closely A. A. R. standards for underframe, center-sill section, 25¾-in. center-plate height and side construction. However, A. A. R. work has not progressed to any great extent, and other construction details are subject to change if the Joint Committee concludes desirable		2,700

sive of the work on standard cars, rather than to pursue this activity further unless the member roads as a whole desire to support this standardization work and are prepared actually to do so by adopting and constructing the new designs when required.

Not long ago the A. R. C. I. debated this question and, upon instructions from its Board of Directors, advised us as follows:

Having prepared, in collaboration with the Car Construction Committee, designs of the standard A. A. R. steel-sheathed wood-lined box, hoppers, steel-framed single-sheathed box and refrigerator car, it is the belief that the original assignment now has been carried out and that the Institute should be relieved of further obligations. Further, that during the period of the depression when working forces were greatly reduced, it was possible to carry on this work, though slowly, but with improvement in business conditions, and the various engineering staffs still depleted, it would be difficult so to continue.

This question now has reached the stage where it must receive renewed consideration and to this end your committee will submit in the near future to the General Committee a statement of all essential facts with request for further instructions. Meanwhile it is desirable to state that without continued co-operation of the A. R. C. I. the 1932 program no longer would be effective, since for the successful prosecution of this work, the combined skill, experience and knowledge of the following group are essential:

(1) The car builders as design and construction specialists.

(2) The railroads for the necessary knowledge of equipment operation, maintenance and utility.

(3) The specialty manufacturers for the development, production and proper installation of improved parts and appurtenances for use as desired by the purchaser.

Regardless of the decision which may be reached with respect to future standard car work, it is now advisedly stated that member roads who already have constructed freight cars to the new designs prepared under the 1932 program or have decided to adopt these designs for future needs, may be satisfied that no mistake is being made and that equipment representing the latest state of the art thus is obtained.

Standard Car Designs Being Completed

As described in detail elsewhere, we are now working, in co-operation with the A. R. C. I. on completion of designs for a steel-framed single-sheathed box and a steel-sheathed refrigerator car, but this work could not be concluded for presentation this year.

Alternate Cast-Steel Constructions for Hopper Cars

Last year we presented in Appendix A specification and complete sets of principal drawings for 50- and 70-ton nominal capacity proposed standard hopper cars which were adopted as standard.

At the same time it was stated that drawings had been released to certain specialty manufacturers for the purpose of having prepared by them, alternate designs incorporating (a) integral cast-steel underframe and hopper constructions complete, and (b) certain parts such as bolsters, interior braces and hopper door frames in cast steel. Further, that as soon as drawings, together with comparative weight had been developed, a supplement containing this information would be made available. This work now has been completed and is submitted in Appendix A to this report.

[Appendix A is made up of 20 plates of alternates to the base design—Plates 626 to 644, inclusive—which are briefly described and comparative weights of cars with the various alternates are given. The drawings include complete car constructions—50-ton and 70-ton capacity—from designs of the Unitcast Company and the General Steel Castings Corporation. In addition, there are drawings of alternate cast-steel cross-bearers, cross-ridge braces, body bolsters, side stakes and hopper frames designed by the Unitcast Company; also cast-steel center sills, underframes and hoppers designed by the General Steel Castings Corporation.—Editor.]

Standard Freight Refrigerator Car

During the past year the committee in co-operation with the A. R. C. I. and the Refrigerator Car Operators has been engaged in joint effort to develop a design for a ventilated refrigerator car based upon accepted fundamentals mentioned in our previous report. Preliminary designs have been prepared for study, also considerable research work has been conducted by roads represented on the committee.

Certain cars have been built and tested for insulative efficiency, air circulation and related features. Comparative tests with equal insulation are being made to determine the relative thermal efficiency of steel versus wood as an outside covering.

Recently one of the largest refrigerator-car operating companies placed an extensive order for steel-sheathed refrigerator cars of a design corresponding as closely as practicable to the general fundamentals as set forth last year, and this work should be definitely helpful in bringing this development to a successful conclusion.

The report on refrigerator cars was signed by the following subcommittee: A. H. Fetters (chairman), F. A. Isaacson, W. A. Newman, E. P. Moses and E. B. Dailey.

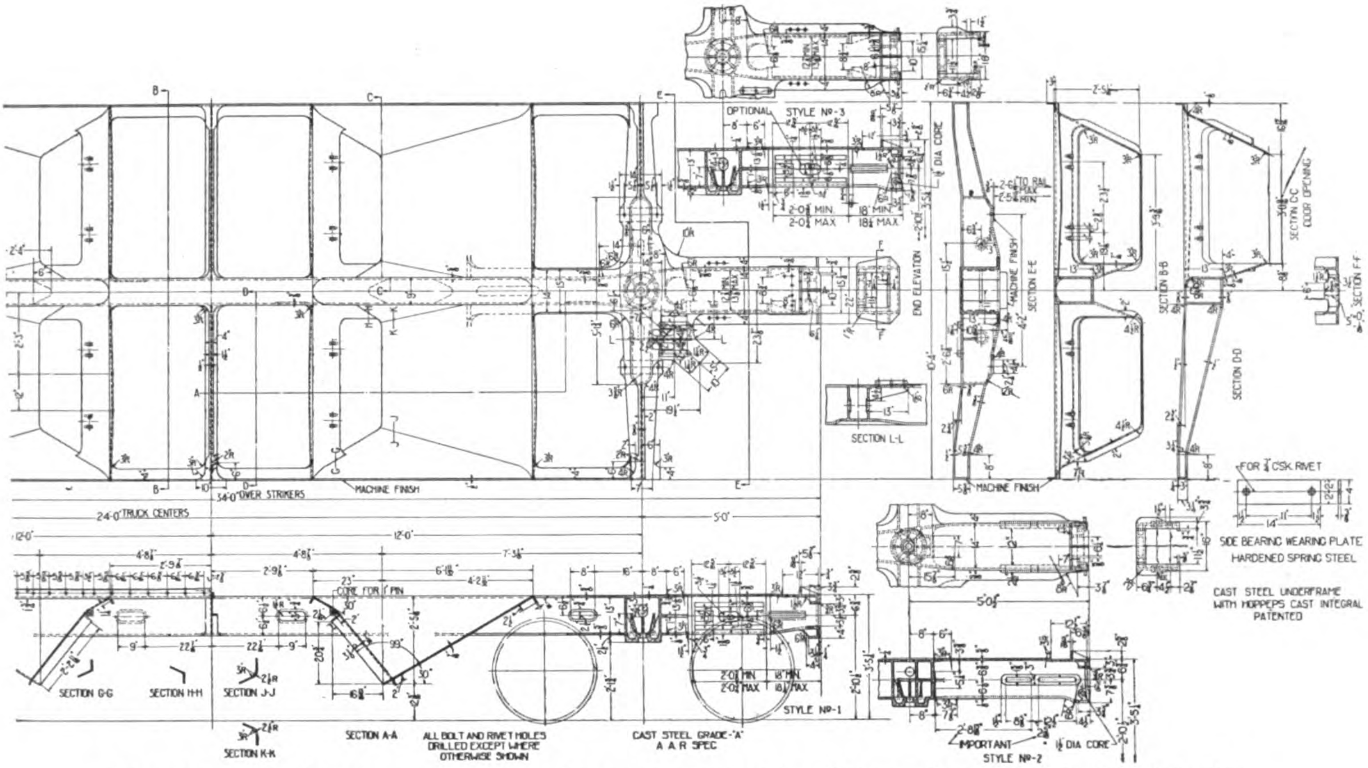
Steel-Framed Single-Sheathed Box Car

During the past year, through the joint effort of the A. R. C. I. and the Car Construction Committee, preliminary work on this design has been accomplished and although not completed, any road desiring to build a car of this type can secure sufficient data through the committee to show the fundamentals for the design now being developed. The subcommittee report on single-sheathed box car was signed by A. H. Fetters (chairman), F. A. Isaacson, W. A. Newman, E. P. Moses and E. B. Dailey.

Service Performance of A. A. R. Standard Box Car

In accordance with the plan outlined in 1935, the C. & O. has now completed a comprehensive road service test of A. A. R. standard steel-sheathed wood-lined box car No. 4 and a steel-sheathed C. & O. box car of substantially the A. A. R. tentative design of 1923. The A. A. R. car No. 4 had previously been submitted to complete deflection and severe impact tests. The C. & O. box car weighed 3,600 lb. more than the A. A. R. car and had a cubic capacity 251 cu. ft. less, due to the fact that while the length and width of both cars was the same, the C. & O. car had an inside height of 8 ft. 7½ in., and the A. A. R. car a height of 9 ft. 4 in.

The two cars, loaded to axle limit (3,600 lb. more in A. A. R. car) with bulk sand and always coupled together to insure the same treatment—although being successively placed in various positions in the train—were placed in service during June, 1934, on the C. & O. for movement between Russell, Ky., and Walbridge, Ohio, a distance of 253 miles each way. The



Alternate A. A. R. 50-ton hopper car with complete one-piece cast steel underframe—General Steel Castings Corporation

operation is northward one day and southward the next day, the cars being moved over the hump on arrival at each terminal. Accurate measurements of the cars were taken before and after completion of the tests.

The road service test did not develop any inherent defects in the construction of the A. A. R. car and it has proved its ability to perform satisfactorily under the several impacts to which it had been previously subjected, in addition to the severe usage in the nine months' road service test covering 35,407 loaded miles. Both cars have since been released into regular interchange service.

The report on the tests was signed by T. P. Irving.

Pullman-Standard Light-Weight Box Car

An experimental light-weight 50-ton box car* was built by the Pullman-Standard Car Manufacturing Company in 1935 as a contribution to the study of reducing the light-weight of box cars. The principal information desired was a determination of how much the weight could be reduced by a new design, rather extensive welding and an alloy steel without either sacrificing strength or materially affecting the price usually paid for a car of such capacity and type.

The car weighed 34,200 lb. empty, or 9,900 lb. less than a corresponding standard A. A. R. car. It was built of Cor-Ten steel and extensive welding was used, it being estimated that 22 per cent of the length of seams were arc welded, 54 per cent spot welded, and 24 per cent riveted. Truck side frames and bolsters, couplers and yokes were of light-weight design, high tensile steel. The center sill was of the same form as the A. A. R. car but of lighter section due to use of high-tensile steel. Side and end sheets were of Cor-Ten steel and lighter than the carbon steel sheets on the A. A. R. car. Couplers were of high-tensile steel but the draft gears were National M-17, the same as on the A. A. R. test car.

After being submitted to the same series of extensometer and deflectometer tests as were employed for the A. A. R. car, the Pullman car was turned over to L. W. Wallace, director of equipment research, for extensive impact tests, these also being the same as used for the standard car. In the impact tests the Pullman car was used as the struck car and a standard A. A. R. car, loaned by the N. Y. C., as the striking car.

During the impact tests over 10,000 measurements were taken. The data are being tabulated and a full report will soon be submitted to the Car Construction Committee.

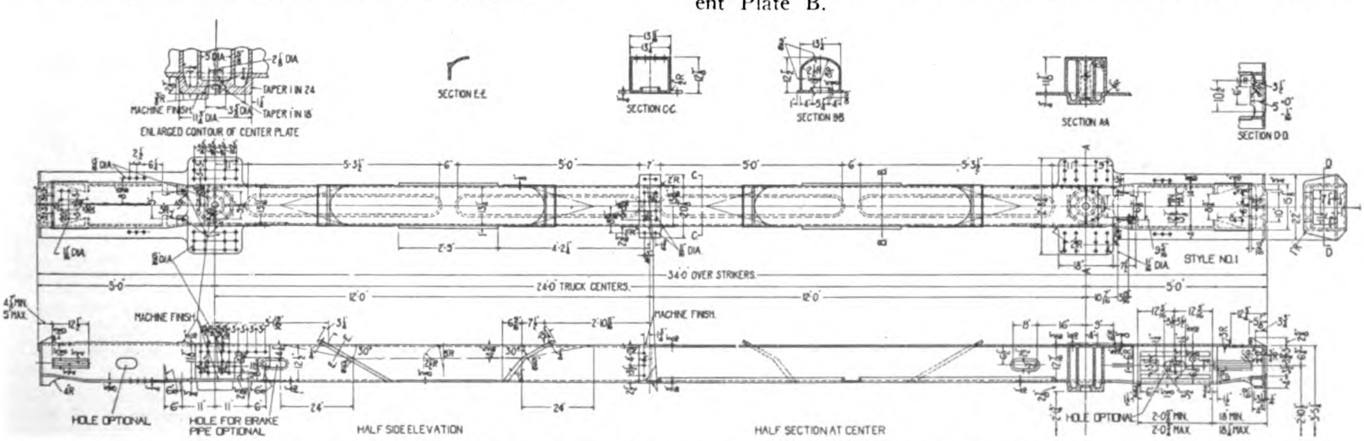
[Brief data tables covering 24 impact tests at speeds ranging from 2.7 to 16 m.p.h. accompanied the report.—Editor.]

This portion of the report was signed by L. W. Wallace.

* For description see *Railway Mechanical Engineer*, July, 1935.

Equipment Clearances and Maximum Outline

Last year we stated that the Engineering Division had been requested to revise and set up as the "Maximum Outline for Equipment in Restricted Service" the diagram adopted by the A. R. E. A. in March, 1934 and also to develop a limiting diagram for unrestricted interchange, somewhat larger than present Plate B.



Alternate cast steel center sill for A. A. R. 50-ton hopper car—General Steel Castings Corporation

Under date of March 14, 1936, we received from the Special Committee on Clearances, A. R. E. A., clearance diagrams marked Figs. 13 and 14, the former being the same as Plate B and the latter marked "Unrestricted for Main Lines."

These were reviewed and the Special Committee on Clearances was requested to consider the following changes and revise Fig. 14 accordingly if found practicable:

Increase over-all width dimension from 10 ft. 7 in. to 10 ft. 8 in., the reason being that many box and auto cars are now built to 9 ft. 2 in. clear inside width, and after making necessary allowance for minimum clearances required for door fixtures and other attachments, the over-all width of such cars is only fractionally under 10 ft. 8 in.

Indicate on the figure information outlined below:

(a) Length of car which can be built thereto; (b) whether this figure represents the outline to which new cars are to be constructed or if intended as the outline to which existing cars are to be maintained. If the former, then with multiple-wear rolled-steel wheels dimension of 4 in. above the rail should be made 5 in., and if the latter, this dimension should be made 2½ in.

Reply has not been received, therefore, progress statement only is being made. When the two figures are completed, it is the intention to have diagrams prepared, including suitable explanatory notes and submitted to letter ballot.

Truck Side Frames and Bolsters

In view of the fact that existing specifications make no provision for the use of alloy steel in side frames and bolsters, tentative requirements were prepared and approved by the Car Construction and Specification committees. These tentative requirements (included as Exhibit A of the report but omitted in this abstract) are used as a guide by the joint subcommittee in granting or withholding approval of all alloy-steel side frames and bolsters of new designs or new materials. Included among the requirements are provisions for static, dynamic and tensile tests.

It is not intended to propose adoption of these as standard requirements to be shown in the Manual, for the reason that dynamic tests are too costly as well as unnecessary for acceptance of frames by individual roads. As soon as a sufficient background of test and service experience with these new designs and materials has been accumulated, standard specifications, based upon static tests, will be prepared and submitted for adoption, as was done for frames and bolsters of carbon steel.

During the past year the manufacturers have continued their research and development work and many dynamic and static tests have been made under the supervision of your subcommittee. As a result two designs of side frames and three designs of bolsters have been approved.*

In addition, applications for approval have been received covering seven designs of side frames and six designs of bolsters.†

Approval of five designs of side frames has been withheld, either because of failure to pass satisfactory tests or because, for other reasons, the designs were considered unsatisfactory for the service intended.

Permission, limited to two car sets only, was given to apply under passenger equipment refrigerators a design of truck having bolster with lateral motion feature, but the truck is not approved for passenger service operation because the bolster arrangement is not regarded as adequate for this service.

Inquiries received from several roads with respect to spring-plankless trucks indicate misunderstanding as to the extent to which use of trucks of this type has been approved. By reference to the report for last year, it will be noted that the Four-Wheel Truck Association design of spring-plankless truck in both Grade B and alloy steel has passed satisfactory static and dynamic tests. Therefore, these designs and any others which have passed satisfactory tests are acceptable for use in interchange freight service. Additional information with respect to trucks of this general type, including certain designs not yet approved, is shown in Tables 2 and 3 of this report.

The subcommittee report was signed by H. W. Faus (chairman), T. P. Irving and T. D. Sedwick.

Non-Harmonic Truck Springs

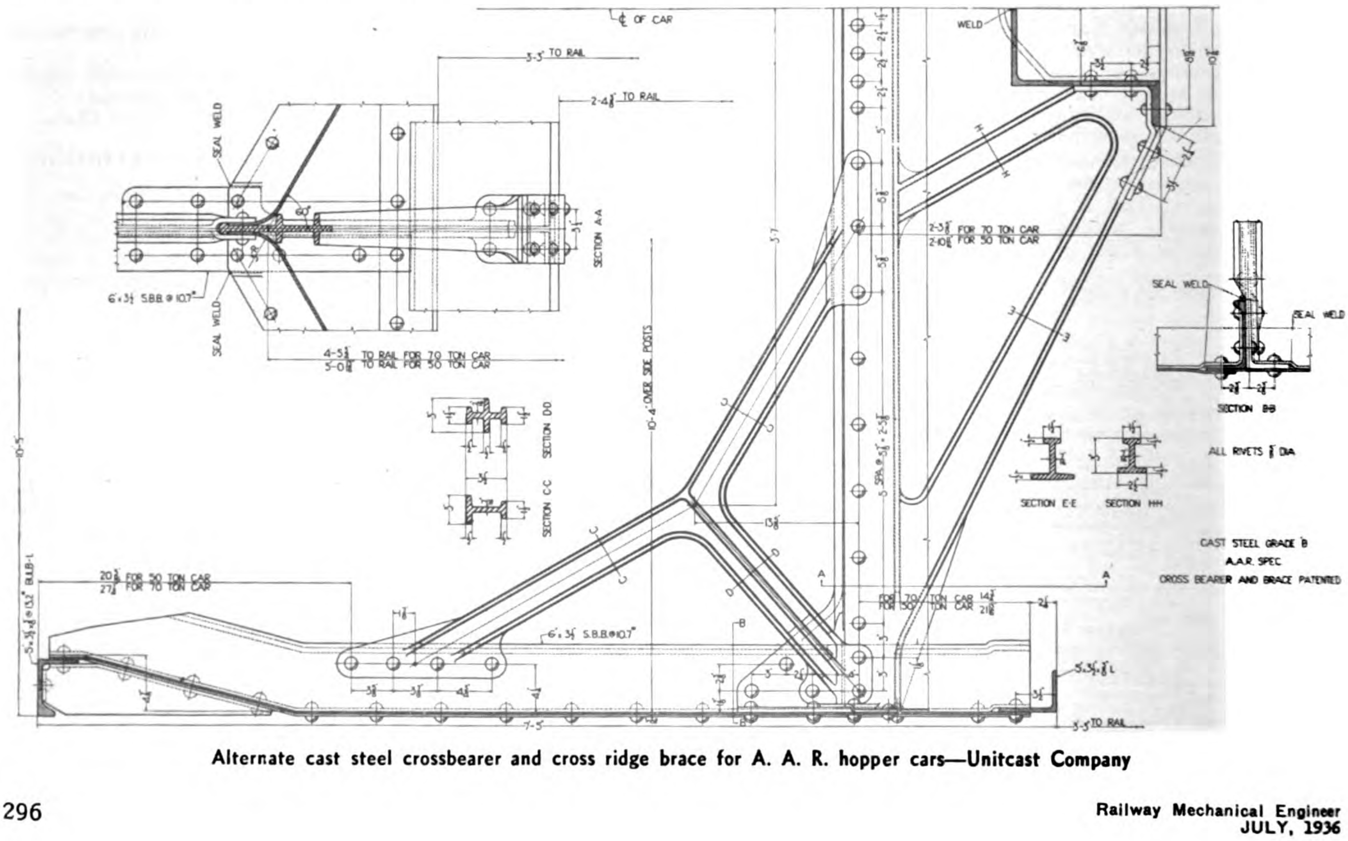
Following completion of the laboratory and road tests conducted during 1933 on devices variously designated as friction springs, snubbers and stabilizers, the devices were placed in service, two car sets of each, under General American Transportation Company refrigerator cars to obtain comparative information as to endurance qualities.

The endurance test is now nearing completion. In order not to prolong these tests unduly, it was decided to remove all springs and special trucks as soon as practicable after the cars to which they were applied had accumulated 50,000 service miles. By December 31, 1935, 15 of the 25 car sets had been removed for the above reason or because of failure. On that date each manufacturer of devices included in the test was furnished with a summary of the results of the tests of his own device up to that time. On April 20 seven car sets remained in the test but the probability is that all will be removed and tests closed by June 1.

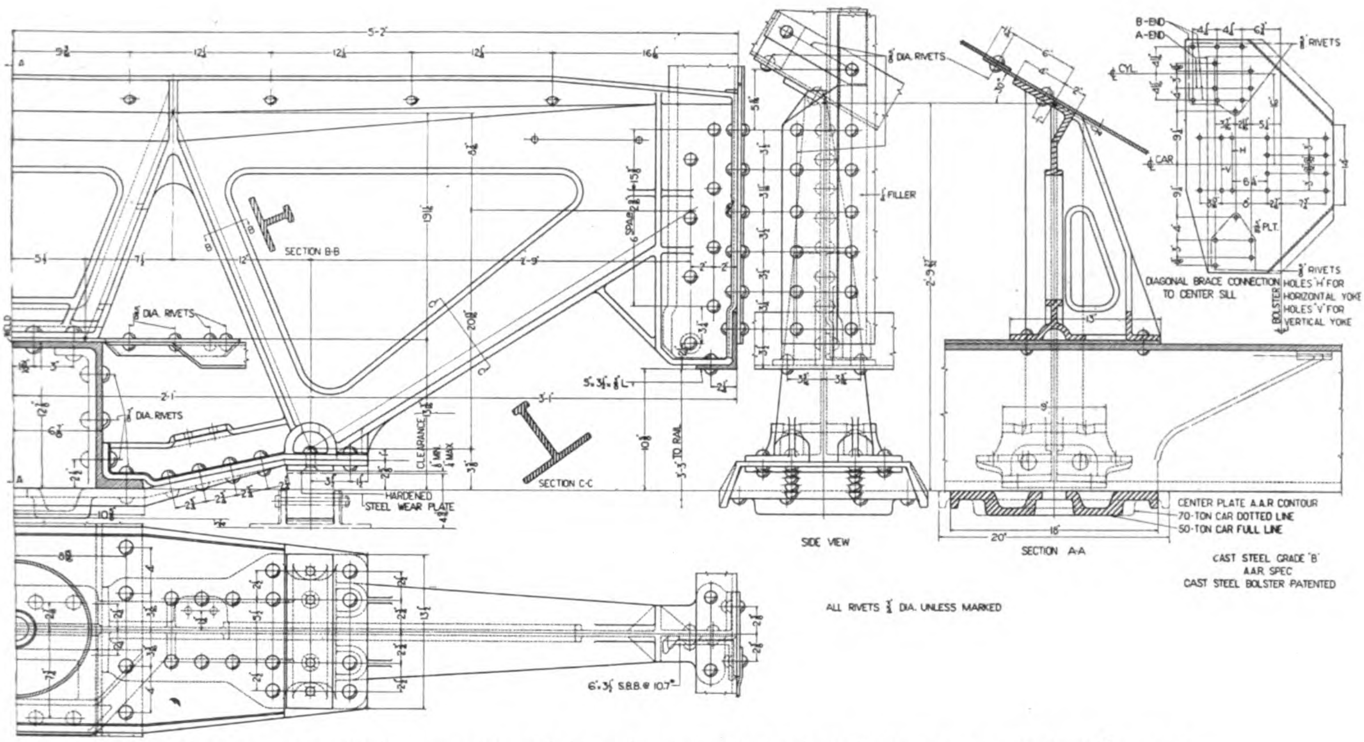
As soon as possible after the remaining springs and devices have been examined and calibrated, a final report will be prepared.

* Table marked No. 2 accompanying the report gave information covering Gould and American Steel Foundries side frames, also bolsters submitted by the Pressed Steel Car Company, Gould, and Buckeye, all of alloy steels. The table also showed applications made.

† Table marked No. 3 accompanying the report included information relative to side frames submitted by the Pressed Steel Car Company, National Malleable & Steel Castings Company, American Steel Foundries, and Standard Car Truck Company; also bolsters submitted by National Malleable & Steel Castings Company, Buckeye, and Standard Car Truck Company. This table also listed applications made.



Alternate cast steel crossbearer and cross ridge brace for A. A. R. hopper cars—Unitcast Company



Alternate cast steel bolster assembly with integral center plate for A. A. R. hopper cars—Unitcast Company

The subcommittee report was signed by F. A. Isaacson (chairman), T. P. Irving and H. W. Faus.

Helical Truck Springs

In the 1932 report, designs of helical springs for 40-, 50-, and 70-ton nominal capacity trucks were included and were later submitted to letter ballot and adopted as recommended practice. These designs were prepared to meet maximum loading and service conditions, to eliminate the continual expense of replacing broken springs, and were to be made of plain carbon steel to the then existing A. A. R. material specifications, being designed to interchange in the space occupied by the then A. A. R. standard spring groups and were based on no inactive coils and a modulus of torsion of 12,600,000 lb. per sq. in.

In 1933 revised specification M-114-34 for heat-treated carbon-steel springs was prepared, submitted to letter ballot and adopted as recommended practice. These specifications include a provision requiring the use of a modulus of torsion of 10,500,000 lb. per sq. in. and 1½ inactive coils.

The principal reasons, at this time, for preparing new designs, to replace the springs adopted in 1932, are as follows:

1—To utilize a better grade of material than now obtainable under revised specification M-114-34.

2—To provide more capacity than the 1915 design but somewhat less than the 1932 springs.

3—Based on information obtained from tests made since 1932, the new designs will result in lower impact forces being delivered into trucks and bodies as well as to the lading in the cars.

4—The new springs adapt themselves more readily in groups, such as Dalman and Double Truss, and also are designed to function more satisfactorily in conjunction with non-harmonic spring devices.

5—The new springs, having greater capacity and more reserve travel while having practically the same total deflection as the 1915 springs, are designed to meet maximum load conditions and at the same time resist breakage in present-day service.

The proposed springs are somewhat more expensive than the 1915 or 1932 in plain carbon steel because of the higher costs of both materials and fabrication. However, for reasons enumerated above, it is evident from the experience and test information available that a change from the 1932 design is advisable and it is believed that the better performance characteristics will fully justify this change from an economic standpoint.

The subcommittee has prepared and now submits designs for the 40-, 50-, 70-, and 100-ton nominal capacity trucks, to be designated as Classes C-2, D-2, H-2, and P-2, to replace the C, D, and H springs now in the Manual and to provide a new design for the P-2 spring. All new springs interchange in the spaces now provided on present A. A. R. groups.

The non-patented spring plates shown on the drawings are designed to eliminate spring bolts used with former designs. These plates are 3/16 in. thick and the overall free height of spring and plates is increased ⅛ in. over the 1932 design. Other spring plates may be used provided they are of equivalent strength and interchangeable with the spring plates shown.

[Tabulated statements of comparative costs, design and capacity characteristics of the old 1915, present standard 1932, and proposed 1936 designs for truck springs on 40-ton, 50-ton, 70-ton and 100-ton freight cars was appended as information. Four drawings of the proposed classes C-2, D-2, H-2 and P-2 springs for freight car trucks with 5 in. by 9 in., 5½ in. by 10 in., 6 in. by 11 in. and 6½ in. by 12 in. axles were also included.—EDITOR.]

The following recommendations are made:

1—That new designs C-2, D-2, and H-2, be submitted to letter ballot for adoption as recommended practice for use in place of springs, C, D, and H, now in the Manual.

2—That new design P-2 be submitted to letter ballot for adoption as recommended practice.

The subcommittee report was signed by T. P. Irving (chairman), H. W. Faus and F. A. Isaacson.

Truck Spring Planks

A progress report including preliminary recommendations was included in the report last year.

Further study has shown that spring planks of various designs are causing trouble and that spring planks applied to cars as recently as 1934 are cracking and breaking. Among apparent causes of failure may be cited the following:

1—Insufficient flexibility.
2—Method of attachment to side frames.
3—General design.
4—Method of fabrication.
5—Material.
6—Irregularities in application.

Spring planks in use today are of so many designs and types, and so few facts were available as to the actual service performance of most of these, that your subcommittee came to the conclusion that more information would have to be obtained. Therefore, a questionnaire designed to obtain detailed records of spring-plank failures for 1934 and 1935 was sent to a representative list of railroads and car owners. When replies have been received, the subcommittee proposes to analyze the data and hopes to be able to submit definite recommendations next year.

The Engineers' Committee of the Four-Wheel Truck Association has co-operated in this investigation. The subcommitee report was signed by F. A. Isaacson (chairman), T. P. Irving, W. A. Newman and H. W. Faus.

Rail Car Motor Axles

In view of the then increasing use of rail motor cars for branch line or local main line train service, the larger and progressively heavier units introduced for these services and the fact that the motor axles necessarily were of dimensions differing in some respect from A. A. R. standards, your committee undertook during 1929, a study in an effort to prevent the intro-

duction of various designs and to provide axles of proper capacities, thus avoiding the tendency towards over-loads and controversies as to capacities and designs of motor axles which should be used under given load conditions.

A subcommittee was appointed from representatives of the then American Electric Railway Engineering Association (now American Transit Association) and the then A. R. A. Car Construction Committee for this purpose and in 1930, tentative recommendations were made pending the results of further investigations. These included a list of axles in sizes from 3¾ in. by 7 in. to 6½ in. by 12 in., inclusive, designated as E-9 to E-13, together with capacities.

Since the work was started the situation has changed somewhat in that specially designed high-powered motorized trains for high-speed main line service have been introduced on various railroads, the use of which may be expected to increase. It is therefore desired to state that the work here outlined and on which final report now is made, pertains only to the original problem of motor axles for rail cars used in branch line or local train service and not to the high-speed motorized train equipment now in use or in cars under development.

It is believed, however, that designs and specifications for the first mentioned type of equipment should be provided for in the recommended practices because comparatively large numbers of such cars still are in use with the prospect or possibility of future increase.

The report for 1934 stated that Rolling Stock Committee No. 1 of the American Transit Engineering Association had then made final and complete report with recommendations as published by the A. T. A. in the 1933 Supplement to the Engineering Manual Sec. E 3-33, under heading "Designs of Axles for Electric Railway Motors." These recommendations received the approval of the American Transit Association.

The 1935 report of your committee stated that the A. A. R. Committee on Specifications for Materials had been requested to check the A. T. A. specifications against those of the A. A. R. for passenger service axle materials and to advise what specification should be followed for rail car motor axles. This has now been done and it is proposed to incorporate in the Manual the following:

[Accompanying the report was a "recommended practice" covering motor axles for gas-electric and similar types of heavy traction rail motor cars which specifies the materials to be used. —Editor.]

Passenger Equipment Axles

During the past year your committee has been instructed to investigate certain failures of axles in passenger service, particularly drive axles for air-conditioning equipment. A joint subcommittee has been appointed consisting of representatives from Wheels, Material Specifications and Car Construction committees.

Information has been obtained from a number of roads on failures of this nature. Studies thus far made indicate that the bending effects from generator pulley action cause only small increases in the axle stresses, whereas the added load of air-conditioning equipment has, in some cases, increased the unit stresses to a point rather close to safe capacity. It is also evident that improper mounting of the generator pulley and poor workmanship may contribute to such failures.

Since receiving original instructions, this assignment has been broadened to include all axles for passenger equipment cars, together with the effects of operating changes, such as increased weights and speeds. This is a broad and intricate subject which will require much further study and research before definite conclusions can be reached. Therefore, a progress report only is submitted.

The subcommittee report on axles for rail motor and passenger cars was signed by B. S. Brown (chairman), K. F. Nystrom and T. P. Irving.

Container Car Design

Last March your committee was instructed to produce a design of container car in accordance with a brief specification from the Federal Co-ordinator of Transportation, work to be completed with a specification by May 15.

Work was undertaken with the understanding that the car desired is of new and experimental character and in view of the absence of experience, work was confined to features of safety and suitability for operation in interchange.

Tentative specifications called for containers of 2,500 lb. tare weight and a load capacity 24,000 lb., containers to consist of fully enclosed boxes mounted on two skid rails spaced not less than 48 in. or more than 54 in. center to center and with clear height not less than 4 in. from bottom of skid to container base.

The car was to be designed to carry five containers and have a light weight of 36,500 lb. Plans were made for a car of Cor-Ten steel construction but due to limited time to work out the design the calculated weight was 44,700 lb. By further study it probably would be possible to reduce the weight to the desired 36,500 lb.

Work was finished and drawings submitted to the Co-ordinator's organization on May 15. A copy of the general drawing with descriptive specification may be obtained by request from the secretary.

The special committee report was signed by P. W. Kiefer (chairman), T. P. Irving, B. S. Brown, H. E. Myers, and H. L. Holland.

Door Fixtures

In last year's report it was stated that a subcommittee had been appointed to check over the door fixture standards now shown in the Manual, for the purpose of eliminating older and obsolete details. This work has not been completed and therefore, progress only may be reported this year.

The subcommittee report was signed by F. A. Isaacson.

Lettering and Marking for Automobile Cars

Development of new designs of automobiles and frequent changes in existing models have necessitated corresponding alterations in automobile loading equipment as installed in automobile box cars.

These changing conditions are met in some cases by complete new installations of loading racks and in other instances by modifications in existing loading equipment. This results in having concurrently in service a number of different styles of loading equipment and obviously requires additional and corresponding designating markings for identification of cars at terminals and in transportation yards.

In order to protect this situation a system of identification marking has been developed and now is utilized almost universally by roads owning or operating automobile cars.

[Accompanying the report were eight illustrations showing modifications of the present standard white stripe painted on the car doors to indicate installation of loaders. The modifications consist of rectangular blocks below the white line together with letters or figures to indicate type of loader.—Editor.]

The foregoing supplements information contained in Note 13 appearing on Fig. 1, between pages 40 and 41, Sec. L of the Manual, and it is recommended that same be shown on a new sheet to be inserted in the Manual immediately following present Fig. 1, and that Note 13 be revised to include suitable reference to additional marking.

Load Limits and Wheel Designs

Interchange Rule 86—The question of stencilled load-limit capacities on freight cars, particularly hoppers, taking into account the various weights of wheels having been raised, a subcommittee was appointed to study the question.

This question was prompted by a feeling that present load-limit ratings discriminated against the use of the heavier wheels; further, that since a rail load-limit capacity has been based on axle capacity, the rail load-limit capacity could be raised somewhat when cast-iron wheels are used.

After an analysis of axle stresses and moments, your subcommittee submits a proposed revision for Interchange Rule 86.

[The report includes stress analyses and a revised axle drawing with new and limit-of-wear dimensions. Two groups of wheels are shown—"heavy" and "light." For "heavy" wheels load limits have been increased for several axles.—Editor.]

The following wheels are considered as "heavy":

Cast iron.
Multiple-wear wrought steel, outside rim from new to 1⅝ in. thick.
Two-wear wrought steel, outside rim from new to 1⅝ in. thick.
Heavy-service cast steel, outside rim from new to 1⅝ in. thick.
Three pairs of any of the above wheel and one pair of others.

The wheels listed as "light" are:

One-wear wrought steel.
One-wear cast steel.
Multiple-wear, also two-wear wrought steel and heavy-service cast-steel wheels having outside rim below 1⅝ in. to scrap limit of the wheel.

The proposed revision of Rule 86 requires the following increases in axle capacities and total rail loads for four-wheel trucks having "heavy" wheels—no changes are proposed where "light" wheels are used:

Axle size	Axle capacity, lb. Light wheels	Axle capacity, lb. Heavy wheels	Total rail load, lb. Light wheels	Total rail load, lb. Heavy wheels
5 in. by 9 in.	32,000	32,250	136,000	137,000
5½ in. by 10 in.	40,000	40,500	169,000	171,000
6 in. by 11 in.	50,000	50,500	210,000	212,000

The subcommittee report was signed by B. S. Brown (chairman), K. F. Nystrom and T. P. Irving.

Definitions and Designating Letters for Freight Cars

Requests have been made for new recommended practice designating symbols and definition to cover a beverage refrigerator

car, without ice bunkers and equipped with two or more fixed tanks for transporting beverages or other liquids in bulk.

The following new definition and symbols are recommended:

"RBT"—Beverage Container Refrigerator. Similar in design to "RS" type, but with no ice bunkers. Provided with two or more fixed tanks for transporting beverages or other liquids in bulk. With or without means of ventilation.

The subcommittee report was signed by C. E. Adams.

New Designs of Light-Weight Freight Cars

Interchange Rule 3—In addition to the work of the joint subcommittee on Side Frames and Bolsters for Freight Car Trucks, as covered elsewhere, and numerous proposed installations of auxiliary brake beam support and bottom rod guard installations submitted during the past year for review and disposition, the full committee has been called upon to check for approval or other disposition, some 20 designs of freight cars complete for interchange service, listed below as information:

Still another problem which came to us was the design of a container car for the Federal Co-ordinator of Transportation.

This section of the report serves as an illustration of the progressive increase in our activities.

BESSEMER & LAKE ERIE

(1) Light weight 55-ton nominal capacity alloy-steel hopper car. Design of body approved immediately but release on light-weight alloy-steel truck side frames withheld pending tests under dynamic loading.

Quenched and tempered hollow bored axles not approved.

Follows closely A. A. R. design. 100 cars.

(2) Light-weight 70-ton nominal capacity hopper car with standard type truck frames of Grade B steel. Approved.

Follows closely A. A. R. design. 1,000 cars.

(3) Light-weight 90-ton nominal capacity hopper car with standard type truck frames of Grade B steel. Approved.

Follows closely A. A. R. design. 1,000 cars.

C. B. & Q. AND P. & L. E.

(4) Item (1) applies also to five experimental cars each for these roads except that A. A. R. standard axles were used under the P. & L. E. cars, therefore, both lots approved except C. B. & Q. axles.

PACIFIC FRUIT EXPRESS

(5) Steel-sheathed wood-lined 40-ton capacity refrigerator following closely design of A. A. R. standard as thus far developed. Approved. 2,700 cars.

NORFOLK & WESTERN

(6) Light-weight 57½-ton nominal capacity hopper car. Approved. Not A. A. R. standard but standard center sill section, bolster center filler castings, truck center plate height and unit hoppers used. 1,000 cars.

E. J. & E.

(7) Light-weight alloy-steel 70-ton nominal capacity hopper car. Approved. Follows closely A. A. R. design.

P. R. R.

(8) Hopper car for bulk cement loading, 70-tons nominal capacity. Approved. This is a special car for which no A. A. R. design is available.

C. & O.

(9) Alloy-steel light-weight 50-ton nominal capacity hopper car. Approved. Follows closely A. A. R. design. 15 cars.

UNION R. R.

(10) Gondola car of 70-tons nominal capacity. General design approved but with request that center sill rail clearance be checked further and changed if necessary. Approval of trucks withheld pending advice as to whether the side frames are to be of Grade B carbon or alloy steel.

No A. A. R. design available. 1,000 cars.

GENERAL AMERICAN REFRIGERATOR EXPRESS CO.

(11) Special type heavily insulated self-clearing permanently enclosed car for handling bulk sugar and similar commodities. Approved. No A. A. R. design available.

MATHER STOCK CAR COMPANY

(12) Multi-purpose gondola car, 40-tons nominal capacity. Not approved account character of side construction.

N. Y. N. H. & H.

(13) Container car designed for use with the "Roloff" type container. Being checked further with the railroad at the time of writing this report.

BETHLEHEM STEEL COMPANY

(14) Welded underframe flat car, 70-tons nominal capacity. Approved. No corresponding A. A. R. design available.

PULLMAN-STANDARD CAR MFG. CO.

(15) Light-weight alloy-steel box car, 50-tons nominal capacity. Approved. Doors, ends and roofs of builder's alternate designs. Otherwise, conforms closely to A. A. R. design. One car.

MOUNT VERNON CAR MFG. CO.

(16) Light-weight refrigerator car, 50-ton nominal capacity for experimental service. Steel underframe and superstructure framing of alloy steel with plywood paneled siding and plymetal panel lining and ceiling. A. A. R. standard Z bar center sill section and 25¾ in. center plate height. Not A. A. R. standard.

(17) Light-weight steel-sheathed box car, 50-tons nominal capacity. Approved. A. A. R. standard in alloy steel including base doors, ends and roof.

GENERAL AMERICAN TANK CAR CORP.

(18) All-steel milk car, 50-tons nominal capacity, having two 3,000 gal. capacity tanks. Approved. No corresponding A. A. R. standard.

RUSTLESS IRON CORPORATION

(19) Light-weight alloy-steel hopper car of 50-tons nominal capacity. Approved. Center sills, bolsters, cross bearers with cross ridge brace arrangement and door frames of cast steel to A. A. R. alternate design. Follows closely A. A. R. design. One car.

COORDINATED TRANSPORTATION, INC.

(20) Convertible sectional railway box car for experimental service. General scheme checked and no features were found which would raise question regarding safety and suitability for interchange service insofar as the design had been developed. Consequently no action necessary. No corresponding A. A. R. design.

AMERICAN CAR & FOUNDRY CO.

(21) Six designs of multiple-unit tank car underframes. Approved insofar as underframes, running gear and other features not included in the Tank Car Specifications, are concerned. No corresponding A. A. R. standard.

Letter Ballot Items

It is recommended that the following items contained in this report be submitted to letter ballot of the members:

1. Designs for helical truck springs for freight car trucks. Recommended practice.
2. Designs for electric traction motor axles suitable for gas-electric and similar types of heavy rail motor cars. Recommended practice.
3. Lettering and marking for automobile rack cars. Standard practice.
4. Revision of Interchange Rule 86 for adjustment of rail load-limit capacities to compensate for the various weight wheels now in general use. Standard practice.
5. Definitions and designating letters for freight cars. Recommended practice.

The report of the Committee on Car Construction was signed by P. W. Kiefer (chairman), chief engineer motive power and rolling stock, N. Y. C.; T. P. Irving (vice-chairman), engineer car construction, C. & O.; W. A. Newman, chief mechanical engineer, Can. Pac.; A. H. Fetters, general mechanical engineer, U. P.; J. McMullen, superintendent car department, Erie; F. A. Isaacson, engineer car construction, A. T. & S. F.; G. S. Goodwin, assistant general superintendent motive power, C., R. I. & P.; E. B. Dailey, engineer car construction, S. P.; B. S. Brown, general foreman, Penna.; K. F. Nystrom, superintendent car department, C., M., St. P. & P.; H. E. Myers, master car builder, L. V., and H. L. Holland, assistant engineer, B. & O.

Discussion

The committee's very evident discouragement at the small practical results, in the form of cars actually built to the standard designs on which both it and the Design Committee of the American Railway Car Institute have devoted so much effort, drew out a lively discussion. It was the wish of those who spoke that the standardization work of the committee be continued so that new developments can be taken into consideration just as fast as practicable, and the standards kept up to date, according to the plan on which the committee is working. Several speakers stressed the quality of the designs resulting from

the joint effort of the best talent of both the railroads' and car builders' designers—which no railroad working alone can hope to equal. It was suggested by C. T. Ripley (Atchison, Topeka & Santa Fe) that perhaps the Mechanical Division should bring the matter before the railway executives. In agreeing with this, F. H. Hardin (New York Central) moved that the subject be brought before J. M. Symes, vice-president in charge of the Operations and Maintenance department of the Association of American Railroads, with the request that he lay it before the Executive committee and the board of directors. The motion was carried.

Action—The report was approved and the proposed revision of Rule 86 ordered referred to the Arbitration Committee before being submitted to letter ballot. The committee was accorded a standing vote of thanks.

Locomotive Construction

The committee on Locomotive Construction has, during the year, given consideration to the following 12 subjects:

A—Design of fundamental parts of locomotives: (1) Universal joints for operating rods of cab valves, injectors, etc.; (2) Driving wheel centers of thin-wall section type; (3) Safety valves for locomotives; (4) Light-weight pistons.

B—Pins and bushings for brake and spring rigging on locomotives and tenders.

C—Roller bearings for locomotives and tenders.

D—Driving and trailer tires.

E—Exhaust steam injectors.

F—Development and use of oil electric locomotives.

G—Pipe fittings for 300 lb. pressure.

H—Revision of Master Mechanics locomotive front end arrangement adopted in 1906—revised 1936.

I—Standardization of valves.

It is recommended that the following four subjects be submitted to Letter Ballot for adoption as Recommended Practice:

(1)—Universal joints for operating rods of cab valves, injectors, etc.

(2)—Pins and bushings for brake and spring rigging of locomotives and tenders.

(3)—45 deg. and 90 deg. street ell fittings for 300 lb. pressure.

(4)—Revision of Master Mechanics front end arrangement adopted in 1906.

Report has been submitted by L. W. Wallace, Director of Equipment Research, outlining a proposed program for investigation of materials, etc., entering into the construction of locomotive boilers. This proposed program of research is being studied by the committee, and report, with their recommendations, will be transmitted to the Director of Equipment Research when their investigation is completed.

Upon direction from the General Committee, the committee has been giving consideration to the construction of locomotive boilers by the fusion welding process. The committee has also cooperated with G. S. Edmonds, superintendent motive power, D. & H., in connection with the design of a fusion-welded boiler authorized for construction by that company. The design and specifications for this boiler have been approved in a report to the General Committee.

Universal Joints for Valve Operating Rods

After studying the design of universal joints used by various roads for the operation of cab valves on locomotives, as well as those for injectors, your committee recommends, for locomotive use, universal joints composed of two jaw members and a center piece as shown in Figs. 1 to 4, inclusive.

[In addition to detail drawings and tables which are omitted in this abstract, the report showed various combinations and applications of the joints in Figs. 5 to 7, incl.—Editor.]

The subcommittee report was signed by H. H. Lanning (chairman), Geo. McCormick, C. Harter, D. S. Ellis, and A. H. Fetters.

Driving Wheel Centers with Thin Walls

In 1934 and 1935, your committee included a statement of roads which had applied driving wheel centers of the thin-wall section type and gave information as to diameter of wheels, type of locomotives, etc., on which these were in use. This statement has been brought up-to-date as of March 1, 1936, and is herewith submitted. The tabulation shows that since the last report there has been a total increase of all makes of thin-wall driving wheels of 500.

[Tabulated data showed applications to date of 342 wheel centers of the Scullin type to 146 locomotives on 15 roads, 854 of the Boxpok type to 208 locomotives on 19 roads, 16 of the box type (L. M. F. design) on six A. T. & S. F. locomotives, four of the Birdsboro type on two B. & A. locomotives, two of Univan type on a B. & O. locomotive and 12 of the Duquesne type on six Penna. locomotives.—Editor.]

Inquiry as to the service rendered by different types of special wheel centers has been made of the roads using them and your committee finds that, with few exceptions, the service rendered is satisfactory. A few defects have been reported but were said to be of a nature common to steel castings and the number smaller than would be expected of an equal number of steel castings of ordinary design. The defects in most cases have been confined to original designs. Manufacturers have made improvements and reinforcement in design, with no trouble reported on latest types.

While marked progress has been made in the application of special design of wheel centers, nine roads express the opinion that this type is still regarded as in the experimental stage, while nine other roads consider it as past the experimental stage, with four roads non-committal. In view of this division of opinions, the committee offers no definite conclusions or recommendations.

The subcommittee report was signed by H. H. Lanning (chairman), Geo. McCormick, C. Harter, D. S. Ellis, and A. H. Fetters.

Safety Valves

In 1934, your committee rendered a progress report on safety valves which evoked some criticism with regard to the material, viz., brass, which was specified for safety valve sleeves also with regard to the methods recommended for determining the aggregate discharge capacity of safety valves for any particular locomotive boiler.

In view of the criticism with respect to materials for sleeves to be used in applying safety valves to locomotive boilers, the committee wishes to revise par. 13 of the 1934 progress report to read as follows:

"Safety valves shall be of the female type and applied to suitable sleeves of brass or steel, the sleeves to be screwed into the boiler or steam dome. Threads of safety valve bases and sleeves are to conform to the railway company's standards."

In criticizing the formula for obtaining the aggregate safety valve capacity, viz.:

5.75 × Heating surface (sq. ft.) = Required aggregate discharge capacity

some expressed the belief that this would give values entirely too low for compliance with I. C. C. Rule 34, which provides for a rise of not more than 5 per cent above the allowed steam pressure.

An evaporation rate of 5.75 lb. of water per square foot of heating surface has been used for years by some of the larger manufacturers of safety valves, and experience with valves proportioned according to this formula has demonstrated that they afford sufficient relieving capacity for boilers of ordinary construction.

Safety valve requirements for locomotive service differ from those in stationary service in that the rates of draft and combustion, under maximum working conditions, are directly proportional to the steam consumption of the cylinders, whereas in stationary service draft is generally produced independently of steam consumption and there is no automatic relation between consumption and the rate of combustion. In a locomotive boiler, therefore, it is only necessary to provide sufficient safety valve capacity to discharge the steam which can be generated over and above the output to cylinders and auxiliaries, whereas in stationary service it is frequently necessary to provide for the maximum evaporative capacity of the boiler.

Conditions under which the amount of steam to be handled by the safety valves of a locomotive becomes maximum seem to be realized in a coal-burning locomotive when the engine is stopped suddenly after running for a considerable period under conditions which require the maximum rate of combustion. Under these conditions, the radiant heat from the fire maintains, for a short period, a rate of evaporation that may, and probably does, approximate the evaporation attained under working conditions; hence the need for special consideration and possibly tests to determine the correct safety valve capacity for a boiler having unusually large grate area.

In an oil-burning locomotive under the same conditions, the cessation of draft which accompanies the closing of the throttle automatically reduces the rate of combustion, as well as the firebox temperature, and compels an immediate reduction in the rate at which fuel is supplied to the firebox; hence in oil-burning service the maximum steam generation to be considered in determining safety valve capacity is that which can be maintained when the fire is forced by the blower with steam from an outside source and all steam outlets from the boiler are closed.

In recognition of the fact that many locomotives constructed during recent years have been provided with boilers having unusually large grates and fireboxes, the committee qualified its

recommendation by including the following paragraph in the 1934 report:

"For boilers having large grate area or short flues, the evaporative capacity should be calculated according to the formulae commonly used for determining boiler capacity in connection with steam consumption of locomotive cylinders, and, in cases of doubt or boilers of unusual construction, the evaporative capacity should be determined by actual test."

If there is any error in the above recommendation regarding boilers of unusual construction, the error lies in the statement that the evaporative capacity of boilers having large grates or short flues "should be calculated according to the formulae commonly used for determining boiler capacity in connection with steam consumption of locomotive cylinders." It is extremely doubtful whether there exist any locomotives which would require safety valves of sufficient capacity to discharge as much steam as would be indicated by the application of Cole's ratios; hence the committee now suggests that the word "may" be substituted for the word "should" in the second line of the above quoted recommendation.

The committee has given consideration to the possibility of standardizing the working parts of safety valves but has reached the conclusion that, in view of the patent situation involved, the recommendations given in the 1934 report with regard to dimensions and construction are all that should be considered at this time.

The subcommittee report was signed by H. H. Lanning (chairman), Geo. McCormick, C. Harter, D. S. Ellis, and A. H. Fetters, Sub-Committee.

Light-Weight Pistons

The 1934 report included a statement of roads which had applied light-weight pistons of the type in which the packing rings perform the function of a bull ring and carry the weight of the piston. This statement gave data as to the number of locomotives equipped, type of locomotive, cylinder dimensions, average mileage per month, etc. This statement has been brought up to date as of March 1, 1936, insofar as replies have been received, and is included as Statement "A."

[Statement "A" which includes 4,022 locomotives on 10 roads has been omitted.—Editor]

The Canadian National now has 602 locomotives equipped with the design shown as Fig. 1 in the 1934 report, no changes having been made in the design but the application of such light-weight pistons has been extended.

The D. & R.G.W. now has 70 locomotives equipped with the design shown as Fig. 4, the only change being the abandonment of the bull ring and the adoption of a one-piece nickel-steel piston.

At least three roads, the B. & M., L.V., and C. & O. have, during the past year, applied pistons developed by the Hunt-Spiller Company. These pistons are of the conical type but the spider and bull ring have been combined in an integral casting of gun iron. The packing rings are of a special sectional design, the segments being forced outward in contact with the cylinder walls by hooplike flat steel springs.

The pistons in the streamlined 4-6-4 type locomotive, Commodore Vanderbilt of the New York Central, are of interest because of the extremely light design made possible by the use of high-tensile steel. The construction of this piston is illustrated herewith. While equipped with these pistons the Commodore Vanderbilt had run 43,200 miles as of March 1, 1936, and the service rendered by the pistons is said to have been satisfactory.

Your committee expects to keep in touch with future developments in light-weight pistons and will report developments as they occur. We have also accumulated data with regard to the light-weight piston valves and expect to report on that subject next year.

The subcommitte report was signed by: H. H. Lanning (chairman), Geo. McCormick, C. Harter, D. S. Ellis, and A. H. Fetters.

Pins and Bushings for Brake and Spring Rigging

The subcommittee submits the following for Recommended Practice. In preparing this information the locomotive builders and the pin and bushing manufacturers were consulted.

Because of the wide variations in diameters of pins and bushings now in use, it was the conclusion of the committee that stock sizes could be reduced, and it is, therefore, recommended that the following sizes of pins and bushings be adopted as Recommended Practice:

[The table includes bushings with inside diameters from ¾ in. to 1½ in. in steps of ⅛ in., from 1½ in. to 3 in. in steps of ¼ in. and from 3 in. to 4½ in. in steps of ½ in. Bushings having inside diameters up to 2¼ in. have walls 3/16 in. thick, those from 2½ in. to 3 in. have ¼ in. walls and larger sizes have 5/16 in. walls.—Editor]

The tubing used for bushings to be accepted with present manufacturers' mill tolerance for diameters, both inside and outside.

All pins are to be finished to not more than 1/32 in. less than nominal diameter.

The material entering into the construction of the pins and bushings to be of a type that can be case-hardened.

The approximate tonnage for pressing in bushings to be on the basis of two tons per inch of outside diameter of bushings. If necessary, the hole to be trued with nominal size straight reamers to suit diameter required.

Pins and bushings to be case-hardened to 1/32 in. minimum depth and to be equivalent to 60 Rockwell C schedule.

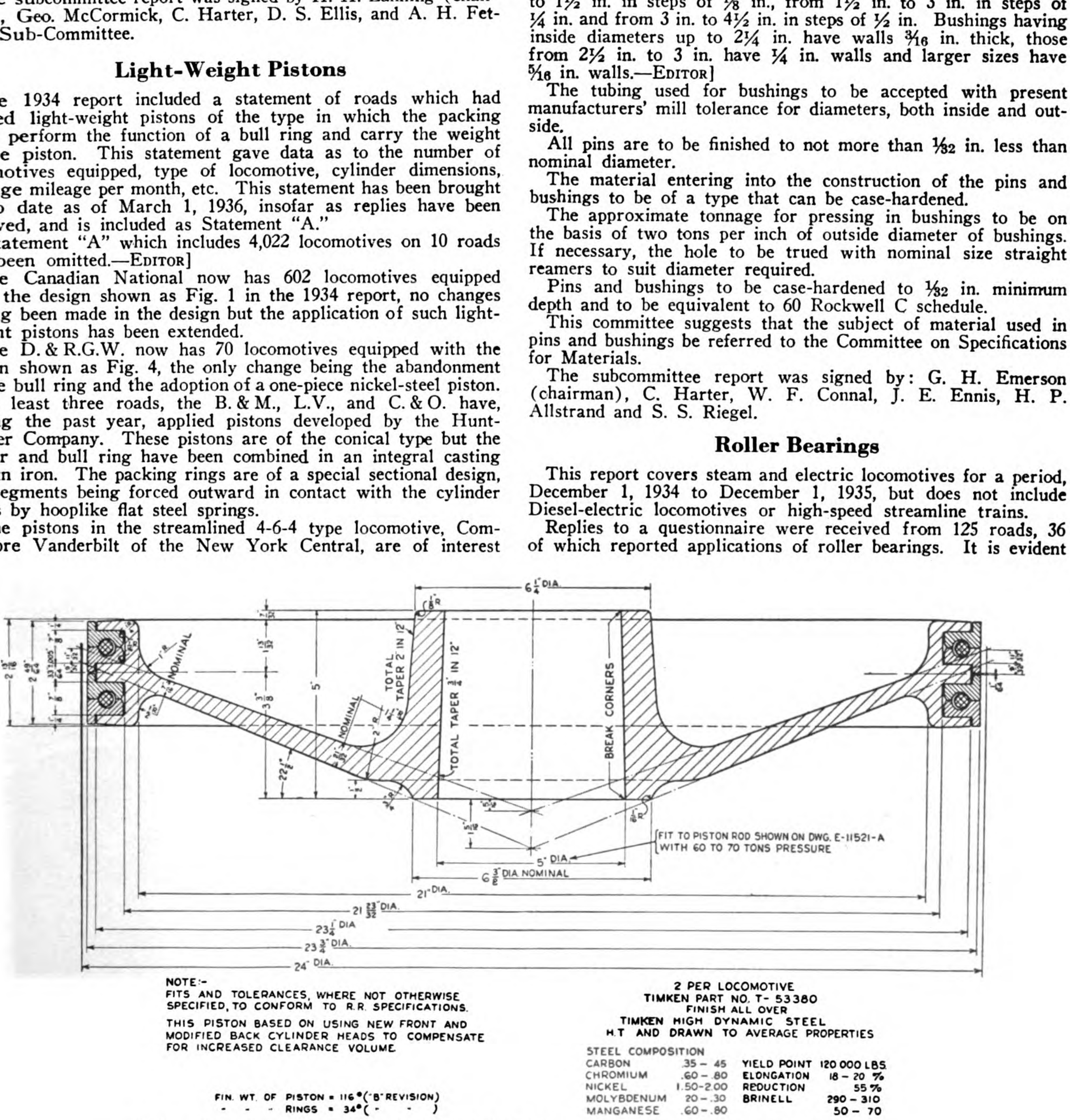
This committee suggests that the subject of material used in pins and bushings be referred to the Committee on Specifications for Materials.

The subcommittee report was signed by: G. H. Emerson (chairman), C. Harter, W. F. Connal, J. E. Ennis, H. P. Allstrand and S. S. Riegel.

Roller Bearings

This report covers steam and electric locomotives for a period, December 1, 1934 to December 1, 1935, but does not include Diesel-electric locomotives or high-speed streamline trains.

Replies to a questionnaire were received from 125 roads, 36 of which reported applications of roller bearings. It is evident



Light-weight piston used on New York Central 4-6-4 type locomotive, the Commodore Vanderbilt

that progress has been made during the past year in extending the use of roller bearings to engine truck, driver, trailer truck and tender truck axles. New applications, including applications which have been authorized but not yet applied, are as follows: 314 engine truck axles and 390 driving axles on electric locomotives and 111 engine truck axles, 70 driving axles, 31 trailer truck axles and 1,104 tender truck axles on steam locomotives. Two engines have been equipped during the year with roller bearings on side rods and main rods and 14 engines had roller bearings applied to various minor valve gear and auxiliary parts. One road has placed orders for 15 4-6-6-4 locomotives which are to be equipped with roller bearings on engine truck, trailer truck and tender axles. Another road has recently ordered 12 4-6-6-4 locomotives, eight of which are to be equipped with roller bearings on engine trucks, drivers, trailer trucks and tender trucks.

Roller bearing failures during the past year were comparatively few and consisted chiefly of worn rollers and cracked and worn races.

Unfortunately, with the introduction of roller bearings, there was not sufficient background of experience regarding the nature and degree of stresses set up in axles by the changed conditions due to substituting roller bearings for plain bearings, consequently considerable trouble has been encountered with broken and failed axles, particularly those of inboard bearing type.

The question of increased speeds also has an important impress on the problem of axle design for roller bearings. Experience gained the last two or three years with axles in high speed streamline train service as well as high-speed electric service has demonstrated that axle stresses increase in a fast ascending ratio for speeds above 70 m.p.h. and that the conventional formula for axle fibre stress cannot be fairly used at these higher speeds.

Whereas freight car axles are designed to carry a maximum of fibre stress, 22,000 lb. per sq. in. and passenger car axles are in general operated at from 80 to 90 per cent of this stress, it is becoming apparent from axle failures at higher speeds that fibre stresses should not be higher than 12,000 lb. per sq. in. for speeds of 100 m.p.h. In addition to this there are certain stresses introduced in roller bearing axles that do not occur when plain bearings are used. On the other hand, roller bearing axles are free from stresses due to overheating that occur with plain bearings.

In steam locomotive service, investigations by various roads have shown that fatigue cracks appear in axles after 300,000 mi. or more of service and for this reason some roads have placed a mileage limit of 250,000 to 300,000 mi. for renewal of roller bearing axles. One road reports that they periodically test axles by magnetic examination. Some roller bearing manufacturers have conducted exhaustive studies into the causes surrounding the fatiguing of axles, with the result that a redesigned axle has been recommended, consisting of an overall increase in diameter and the placing of pressed-fit members, such as the wheels and bearing races, on large diameter of the axle.

Some of the redesigned axles have been applied, but have not had sufficient service to arrive at definite conclusions, however, the subcommittee hopes to have additional information for the next report.

The subcommitte report was signed by: A. H. Fetters, R. G. Bennett, and W. F. Connal.

Driver and Trailer Tires

This committee, with the co-operation of members of the Technical Committee of Tire Manufacturers Association has reviewed the reports from roads covering locomotive and trailer tire failures for the period of December 1, 1934, to December 1, 1935. The data were supplied by 128 roads, of which 59 representing 35,458 locomotives in service, reported 613 tire failures for the year, and 69 representing 2,498 locomotives, reported no failures. Of the failures 212 were attributed to the manufacturing process, 238 to railroad responsibility and 163 not classified.

It is apparent that some roads did not thoroughly investigate and reach definite conclusions as to the cause of tire failures. While there has been an improvement since calling attention to this matter last year, the fact remains 26 per cent of the failures reported since that time were discarded because of lack of information. It is important that this be given greater consideration by all reporting roads for the ensuing year.

Shelled Treads—Tabulation of the causes of tire failures shows a large number of defective tires due to shelled out treads. It has been previously indicated that only tires which were shelled out more than ⅜ in. should be reported. Due to variations in reports and the fact that a number of roads made no report of shelled out tires, leads us to believe that many shelled treads are turned before they reach ⅜ in. in depth, and, therefore, not reported. One road reported 42 trailer tires, another road 47 trailer tires removed from service on account of shelled treads in excess of ⅜ in. in depth. This emphasizes the importance of making a more careful investigation of this type of defect. Your committee has asked the secretary in procuring data for the period June 1, 1936, to December 1, 1936, to request reporting roads to keep, and make report of all tires which have to be removed from locomotives and trued up in a lathe or discarded by reason of shelling. The reporting road will give depth of shelling, whether wheel center was of solid or spoke design, and in the case of trailer tires whether the locomotive was equipped with a booster and/or brakes. This modifies previous instructions relative to a ⅜ in. limit, but the additional information is required to enable us to arrive at a definite conclusion if possible as to the cause of shelled treads and the method which must be followed to minimize this type of failure.

The subject of shelled treads has been discussed with the Technical Committee representing the Tire Manufacturers, particularly as to whether they should be considered under the heading of railroad or manufacturing responsibility. The result thus far has been a memorandum on "The Problem of Shelling in Locomotive Tires and Wheels" submitted by the Tire Manufacturers Technical Committee.

[The memorandum referred to is a lengthy discussion of shelled treads and included with it are illustrations and photomicrographs of treads with this defect. Two of these photomicrographs are included in this abstract.—Editor.]

Heat-Treated Tires—The practicability and economy in the use of heat treated tires has also been given consideration. We are advised by the Tire Manufacturers Technical Committee that:

"The application of heat-treated tires is still in a state of development. The earliest applications were made on trailer wheels in an endeavor to minimize shelling where particularly severe service conditions were to be met. The treatment was chosen to give as great an increase in hardness and strength as possible, with ductility as high as or higher than that of the untreated tires. These tires have continued to give satisfactory performance for a number of years in trailer service.

"More recently a number of roads have applied heat-treated locomotive driving tires with physical properties similar to those of trailer tires in the hope of securing greater mileage between

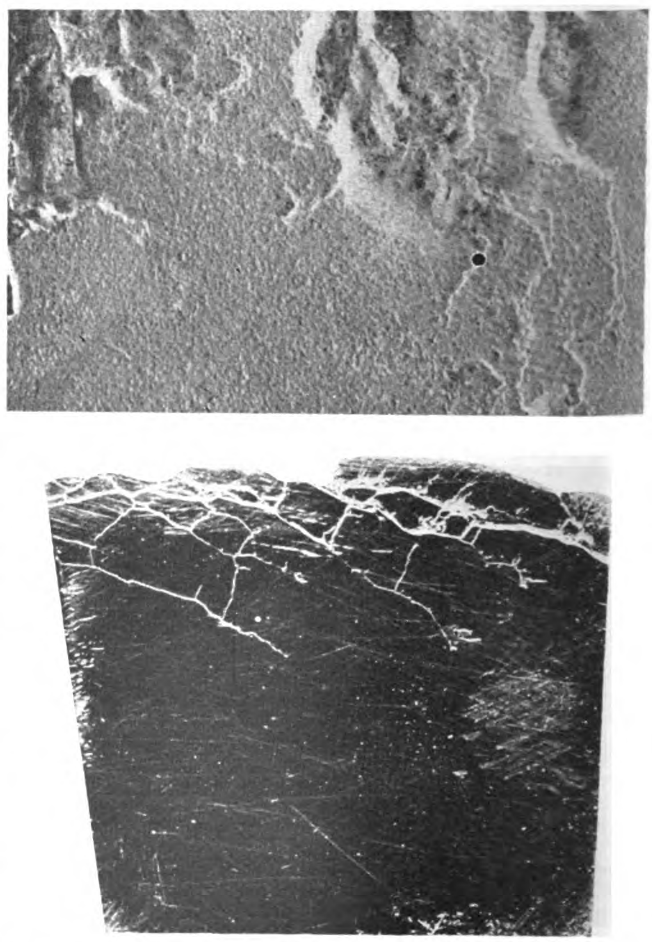
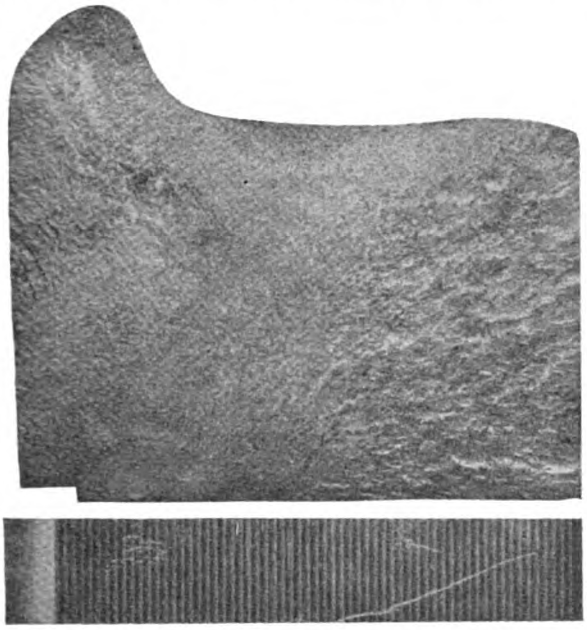


Photo-micrographs, magnification of three diameters, of the tread surface of a shelled out tire and a cross-section showing fatigue cracks

turnings. In many cases satisfactory results have been obtained, but there is considerable evidence to the effect that with heat treatment giving a high degree of hardness it is important that the tire shall be fully and uniformly supported by the rim of the wheel. If the support given to the tire is not uniform because of distortion of the wheel center, improper shimming or other causes, the tire is subject to flexure at the unsupported points. In addition the bore of the tire at these points may be subject to corrosion which greatly reduces the fatigue strength of the tire section. A tire of low elastic limit may distort permanently and adapt itself to the contour of the center, while



Tire failure caused by rough tool marks shown at bottom of illustration

a treated tire of higher elastic limit may be subject to continued flexure leading to failure. A considerable number of the failures of heat treated tires are attributable to this cause.

"As the use of heat treated driving tires is still in progress of development definite specifications cannot be set up. It is the belief that when more information is obtained from service tests definite standards may be possible."

It is therefore essential that those reporting roads who are using heat-treated tires keep this committee informed with regard to the failures they are experiencing, with such additional information as may be helpful in pursuing this subject.

Shop Practices—Your committee is doubtful as to whether mechanical officers, or their responsible subordinates, generally appreciate the large number of tire failures traced to cracks in the bore, developing from rough tool marks, nicks and corrosion, wheel centers out of round, and welding and torch burns. (See accompanying illustration.)

The mechanical officer of one railroad operating over 2,000 locomotives reached the conclusion all the tire failures on his road for the year were due to faulty shop practices. These failures can be much reduced by ordinary care, precaution and proper shop practices.

This committee wishes to acknowledge the co-operation of the tire manufacturers for their assistance. Important data have been gathered thus far and the investigation should be continued. The value of this study will finally depend on the thoroughness of reporting roads in investigating and correctly allocating the causes of their tire failures in future reports.

[Accompanying the report was a comprehensive tabulation of the tire failures reported for the year ended Dec. 1, 1935.—Editor.]

The subcommittee report was signed by R. G. Bennett, W. I. Cantley, J. E. Ennis, E. E. Chapman and T. C. Sedwick.

Exhaust-Steam Injectors

Feedwater Heaters—Until this year the subject of feedwater heaters and exhaust-steam injectors has been carried on the docket, but in view of the almost universal application of feedwater heaters to new power and existing modern power, it is the view of the Locomotive Construction Committee that feedwater heaters are no longer experimental devices, and should be dropped from the docket.

Exhaust-Steam Injectors—During 1935 there was little activity in the field of exhaust steam injectors. One road reported six applications and another road reported four applications. One road has recently ordered 15 4-6-6-4 locomotives, five of which are to be equipped with exhaust steam injectors.

Another road reports that the Turbo type injector in use has been giving satisfactory service but they have made no comparative tests to determine economy obtained.

This is submitted as a progress report and it is the intention to continue to investigate these devices.

The subcommittee report was signed by A. H. Fetters and W. I. Cantley.

Oil-Electric Locomotives

Your committee has continued investigations of developments and submits statement showing the number of Diesel-electrics in service in the United States and Canada as compiled from statistics and records of installations of various units. [Table shows 192 locomotives installed since 1925.]

Statement includes 46 oil-electric battery locomotives operated from both internal power generated by Diesel engines as well as external power obtained from trolley or third rail connections but does not include gas-electric nor butane-electric locomotives.

About 85 per cent are 300 to 600 hp. capacity which evidently are considered most favorable for general switching assignments as with the higher ratio of tractive effort per total weight of locomotive obtainable from oil-electrics, it is possible to substitute them for steam locomotives of 800 to 1200 potential horsepower ratings and effect economies in operation by lower fuel rates and savings of wages and enginehouse expense. However, to obtain the greatest savings it is essential that the oil-electric units are operated in service assignments of 16-24 hours per day.

Recent installations show that heavier types of oil-electric locomotives, 900 to 1200 hp. capacity are being used in switching and transfer service and larger units of 1,600 to 2,000 and 3,600 hp. are being introduced into road and helper service, but the initial cost of the larger units will require assignments from which greater locomotive mileage per annum can be obtained than possible with the steam locomotives replaced. Improvements in design and construction are evidenced in the most recent Diesel-electrics which with higher availability assured and increase of locomotive miles per annum attained, economic operations can be anticipated.

We have made no comparisons of operation costs per hour or per locomotive mile for any oil-electrics of any ratings since their work assignments, power factor developed, territorial locations, etc., govern these costs to a considerable extent, and actual costs of operations would not be comparative except under precisely similar conditions.

The average service life of these locomotives or cost of repairs also cannot be consistently estimated or computed from information available and considerably more performance and development information must be available to establish these characteristics.

In addition to this some roads are using types of Diesel-powered trains. Since the Union Pacific streamliner, and the Burlington "Zephyr" streamlined units—both Diesel-driven trains—made their appearances, the "Comet," the "Flying Yankee," "The Rebel," "Royal Blue," "Green Diamond," "City of Portland," and similar trains have come successfully into use and doubtlessly much progress will be made with such Diesel powered trains in the future.

The subcommittee report was signed by S. S. Riegel (chairman), W. F. Connal, and W. I. Cantley.

Pipe Fittings for 300-Lb. Pressure

Your committee has considered the proposal that we include the 45 and 90-deg. street ell fittings with the 300-lb. unions and fittings of the nut and nipple type adopted for recommended practice in 1931.

Railroads canvassed develops the fact that there is a general demand for this type of street ell fitting, although a few roads do not use them.

We, therefore, believe it is consistent to include them in this standard, then adopted, and so recommend, leaving their use optional, and in that connection submit the attached illustrations, dimensions and characteristics of the sizes recommended for the 45 and 90-deg. street ells to be included. [Drawings omitted.]

The subcommittee report was signed by S. S. Riegel (chairman), W. I. Cantley, and J. E. Ennis.

Master Mechanics Front End Arrangement

The subcommittee appointed to consider a revision of the design known as the "Master Mechanics" front end as described in the 1906 proceedings of the American Railway Master Mechanics Association submitted a comprehensive report based on recent standing and roads tests made while redrafting various classes of bituminous coal burning locomotives.

[Due to the importance of the subject, this portion of the report will appear as a separate article in a later issue.—EDITOR.]

The subcommittee report was signed by D. S. Ellis (chairman), and A. H. Fetters.

Standardization of Valves

Upon request, a survey was made as to the attitude of the railroads in connection with the standard A. A. R. 300-lb. globe and angle valves, and the information received indicates that out of 106 roads reporting, 53 stated that they have adopted the valves as standard, 10 propose to adopt, 26 have not adopted nor propose to adopt, and 17 were indefinite. The 63 roads which have adopted or propose to adopt the valves as standard represent 33,022 locomotives out of a total of 48,767 locomotives.

The subcommittee report was signed by J. E. Ennis (chairman), S. S. Riegel, and W. I. Cantley.

The full report was signed by W. I. Cantley (chairman), mechanical engineer, L. V.; H. H. Lanning (vice-chairman), mechanical engineer, A., T. & S. F.; R. G. Bennett, general superintendent motive power, Penna.; G. McCormick, general superintendent motive power, S. Pac.; W. F. Connal, mechanical engineer, Can. Nat.; G. H. Emerson, chief motive power and equipment, B. & O.; A. H. Fetters, general mechanical engineer, U. P.; J. E. Ennis, engineer assistant, N. Y. C.; S. S. Riegel, mechanical engineer, D., L. & W. (deceased); D. S. Ellis, mechanical assistant to vice-president, C. & O.; C. Harter, chief mechanical engineer, Mo. Pac., and H. P. Allstrand, principal assistant superintendent motive power and machinery, C. & N. W.

Discussion

Mr. Cantley introduced the chairmen or other members of the subcommittees, who made the presentations of the various parts of the report. With respect to driving wheel centers with thin walls, the question was asked whether difficulty had been experienced with higher hub temperatures with the new wheels. Representatives of the Missouri Pacific, the New York Central and the Chesapeake & Ohio reported no trouble from this source. The Chicago & Eastern Illinois reported six failures of the early design of this type of wheel center. The redesigned wheels with which the failed wheels had been replaced had given no trouble after two years in service.

The section of the report on roller bearings drew forth considerable discussion in answer to a request from the floor for descriptions of the axle troubles which had been experienced on locomotives equipped with roller bearings. The difficulties on several roads for which representatives spoke all arose within the portion of the axles covered by the bearing and were diagnosed as starting from detail checks or fractures in the surface of the axles adjoining the edges of the inner bearing races which are shrunken on. More trouble is experienced with inboard bearings than with those on the outside of the wheel. W. H. Flynn (N.Y.C.), who reported trouble of this kind, said that it had been overcome by new designs, and expressed great confidence in the bearings. D. S. Ellis (C. & O.), reported that on inspection of engine truck axles fitted with roller bearings at the time of each Class 3 repair it was found necessary to remove all axles from this cause.

A. H. Fetters (U. P.) called attention to the effect on the stresses on the axle of the shrinking on of races and spacer rings; an effect which might produce stresses at the surface of the axle in excess of its elastic limit. He said it had been suggested that rolling of axle surfaces at these ring seats might improve conditions by increasing the strength of the material. H. W. Faus (N. Y. C.) doubted the value of the cold rolling process because the resulting sacrifice of ductility of the surface metal tends to reduce its fatigue strength and make it more susceptible to the effect of any slight surface scratches which might be present. The only information, he said, on which to judge the effect of the cold rolling process is that obtained from endurance tests with small, highly polished specimens, results of which admittently would be severely affected by the slightest surface defect and in which ductility is of less importance than in the case of axles.

Another subject which drew forth more than ordinary comment was that of driver and trailer tires. The committee stressed the handicap it suffered from the lack of adequate information in the reports of shelled treads which railroads are sending to the committee. D. J. Sheehan (C. & E. I.) related a number of the peculiar circumstances which have been noted in connection with shelled-out trailer tires on that road, many failures from which cause were experienced during the past winter. About 85 per cent of all of the failures, he said, occurred on one class of Mikado type locomotives in fast freight service. Of the failures on this class of power 93 per cent occurred on the left side of the locomotive. He said that he had found others were experiencing the same peculiarity. The only condition he could find which would seem to have any relation to this peculiarity was the fact that on a double-track railroad the inside track rail, on which the left-hand wheels run, is less flexible than the outside rail.

Lawford Fry (Edgewater Steel Company) expressed the opinion that the increase in tread failures is due to increases in speed and load. On one road for which he had the data he said that the number of shelled tread failures in 1935 was twice as great as in 1934. That this was not the result of changes in reporting was indicated by the fact that failures caused by shattered rims, a defect for which the manufacturer is clearly responsible, were the same in both years. The facts available indicate that the failures probably averaged about one-half per cent of the wheels in service per year. He also presented data indicating that the failures from tread shelling on tenders were much greater on the leading axles of each truck and much greater on the front truck than on the rear truck. He pointed out that the solution does not lie with the metallurgist alone but must include a study of the mechanical design of the equipment.

J. W. Burnett (U. P.) said that locomotive tire failure studied on the Union Pacific occurred in tires which had received their last turning. The practice on that railroad, he said, is to fit tires to individual wheel centers and not to permit the use of shims. To this he attributes their present lack of failure. He expressed the opinion that the major responsibility of developing a steel wheel suitable for all around service rests upon the manufacturers. C. Cromwell (B. & O.) said that his railroad had experienced practically no trouble from tire failures. He mentioned a few failures of trailer tires through the bolt holes where they were bolted to the rim of the wheel. This road, he said, turns up the wheel centers when new tires are required and fits the tires to the center.

In connection with Exhibit H, covering the revised master mechanics locomotive front and arrangement, L. Richardson, (B. & M.) mentioned some excellent results being secured with annular ported nozzles on that road. Mr. Fetters stated that in general the drafting ratios proposed in the report will result in good steaming locomotives. He said that all types of stack and nozzle combinations have been tested on the Union Pacific, the best results being secured with the multiple-ported nozzle with which a vacuum of about one inch is secured per pound of back pressure.

Action.—The report was accepted and the recommendations referred to letter ballot.

Tank Cars

During the year the committee considered a total of 328 dockets and applications for approval of designs, of which 186 covered shipping containers for application to new cars or for replacement on existing cars. Nine applications covered 28 multi-unit cars to be used for the transportation of 15 Class I. C. C.-106-A-500 one-ton containers each. One application covered a new underframe and trucks for use in mounting an existing tank-car tank. A total of 112 applications covered alterations in existing equipment. Twenty applications were received for approval of tank car appurtenances.

Applications	Tank Car Appurtenances
2	Angle valves, 2 in., for I. C. C.-105-A series tank car tanks.
1	Angle valve, 1 in., for I. C. C.-105-A series tank car tanks.
1	Frangible disk safety device, with ignition element, for I. C. C.-107-A containers.
1	Manhole cover, modification in design.
2	Manway reinforcement, Class I. C. C. 105-A series, fusion welded tank car tanks.
1	Outlet chamber arrangement, adaptable for different ladings.
1	Outlet valve, spring type, for tanks transporting a fertilizer compound in solution.
1	Outlet valve, for replacement, on existing tank car tanks.
1	Outlet valve rod stuffing box.
1	Outlet valve, positive type.
1	Safety valve, 5 in. with resilient gasket, modification in design.
1	Safety valve for I. C. C.-105-A series tanks in tetraethyl lead service.
2	Shipping containers, Class I. C. C.-106-A-500, proposed design.
1	Steam heater coil arrangement.
1	Tank stabilizer, to replace tank bands.
1	Unloading arrangement for tank car tanks used in ammonia water service.
1	Valve arrangement for Class I. C. C.-106-A-500 shipping containers.

Fusion Welded Tanks

Following a hearing before the Interstate Commerce Commission, held September 5 to 7, 1934, the commission, under date of November 13, 1935, denied the petition of the association for approval of fabrication by the fusion-welding process of tank-car tanks to be used in the transportation of all dangerous commodities, except chlorine. The commission likewise denied peti-

tions of E. I. du Pont de Nemours and Company and the Union Tank Car Company for approval for experimental service of tank-car tanks fabricated by the fusion-welding process. The commission did, however, approve the petition of Grasselli Chemical Company for approval for experimental service of 10 fusion-welded, rubber-lined tanks for the transportation of muriatic acid for the reasons that muriatic acid will subject these tanks to low internal pressure; difficulties due to moisture remaining in tanks after hydrostatic test pressures, and the difficulties experienced in applying rubber lining over rivet heads and the edges of lap seams in tanks constructed with riveted and calked seams will not be present in the smooth interior of tanks fabricated by means of the fusion-welding process.

By petition, dated December 19, 1935, the Union Tank Car Company asked for a reconsideration of its petition and requested the right to use in experimental service in the transportation of liquefied petroleum gas 25 cars to be equipped with tanks fabricated by means of electric fusion-welding, but otherwise conforming to Shipping Container Specification I. C. C. 105-A-400.

The commission, under date of April 15, 1936, upon further consideration of the record and in the light of the added facts disclosed in the petition of the Union Tank Car Company for reconsideration, authorized further service tests of petroleum products in the 10 cars already built and authorized the construction of 15 additional cars to be constructed in all respects similar to the 10 cars already constructed.

The commission, in its order of April 15, 1936, also authorized the construction for experimental service of one tank-car tank of nitric-acid-resistant metal by the fusion-welding process for the E. I. du Pont de Nemours & Company and 25 tank-car tanks for experimental service in the transportation of petroleum products for the Phillips Petroleum Company; the tanks to be constructed in accordance with I. C. C. Specification 105-A-300 except that fusion-welding may be substituted for the method of construction covered by that specification.

In granting the authority to construct and operate the foregoing fusion-welded tank-car tanks in experimental service, the commission requires certain inspections and reports to be made by the owners or operators of these cars.

The Chlorine Institute, Inc., has submitted an improved safety valve for use on cars transporting chlorine. This valve has been developed in accordance with results of tests conducted in co-operation with your committee. The committee has authorized The Chlorine Institute, Inc., to manufacture and place in service 50 valves of this improved design.

Classification of Tank Cars

The matter of re-classification where a new tank is applied to an existing underframe has arisen during the year due to the large number of tanks of I. C. C. classification which have been built for application to existing underframes and trucks. For transportation and service requirements, tank cars shall always bear the classification of the tank or tanks mounted thereon. In other words, if a new Class I. C. C. 103 tank-car tank is mounted on an existing underframe which previously carried an A. R. A. III tank, the car shall be re-classified as I. C. C. 103.

In connection with this application of a new tank to existing underframe, the requirements of Par. (15), Section (t), Interchange Rule 3, should be met. This rule provides that, in the application of new tanks to secondhand underframe and trucks, the underframe must at least conform to the A. R. A. Specification for Class III tank cars, effective May 1, 1917 to July 1, 1927, and the trucks must be equipped with cast steel side-frames meeting A. A. R. specifications.

The committee has received applications during the year for the approval of welded splash angles on the outside of acid tanks. The committee is definitely opposed to autogenous welding on tank-car tanks when it is not possible to properly anneal the tank as a whole after such welding has been performed. The committee will, therefore, not approve any further requests for the use of welded splash angles on riveted tank-car tanks.

As result of continued unfavorable conditions, your committee has recommended to the Arbitration Committee the extension to January 1, 1938, of the following requirements of Interchange Rule 3: Section (t), Par. (8)—Head-block anchorage on tank cars; Section (t), Par. (9)—Wood shims between longitudinal anchorage and underframe, on tank cars; Section (t), Par. (14)—Dome covers secured by hinge or chain, on tank cars; Section (t), Par. (16)—Class I tank cars prohibited in interchange.

Protection of Air Vents, Venting and Loading Pipes

The committee has received a number of applications for the alteration of cars, both of A. R. A. Class III and I. C. C. Class 103 designs, involving the application of air vents, venting and loading pipes, etc., on the dome without being properly protected by being set into a securely covered recess or by means of a cast, pressed-steel, or malleable-iron housing with a cover that can be securely closed.

It is the opinion of the committee that, when changes are made in cars of former A. R. A. classification, they should be made to conform as far as practicable to the specifications in effect for cars of corresponding I. C. C. classification even though the commodities to be transported are of a non-regulatory character.

In accordance with this opinion, on future applications for cars equipped with air vents, venting and loading pipes, etc., on the dome, proper housing or protection cover will be required in accordance with paragraph I. C. C.-11 of Specification 103.

It is the unanimous opinion of the committee that the welding of placard holders by either tack welding or edge welding to the shells of tank-car tanks should be prohibited in the future but that this action should not be retroactive as to any cars now in service covered by previous approval of this practice. Accordingly, the committee will no longer approve this method of applying placard holders to tank cars.

It is the further opinion and recommendation of the committee that, when placard holders which have been previously welded to tank-car shells become loose, they should not be re-applied in this manner but that the regular placard board should be applied as covered by the standard tank-car specifications.

Suggested Changes in Specifications

The committee has recommended to the Bureau of Service, Interstate Commerce Commission, and to the Bureau of Explosives that a sentence be added to paragraph 6 (a) of Specification I. C. C.-103, making this paragraph to read as follows: "I. C. C.-6. Riveting.—(a) For computing rivet areas the effective diameter of a driven rivet is the diameter of its reamed hole, which hole must in no case exceed nominal diameter of rivet by more than 1/16 in. All rivets must be driven hot. *The use of two 'liners' not to exceed 1 in. in width and 1/16 in. in thickness, placed at an angle across the longitudinal seams between two rows of rivets near the internal tank heads on compartment cars to prevent the liquid from passing along the longitudinal seams from one compartment to another while cars are being water tested, will be permissible.*"

Upon recommendation from the Committee on Tank Cars in its report for 1933, the Association adopted as recommended practice, by letter ballot, designs of dome covers for tank cars of Classes I. C. C. 104-A and I. C. C. 105-A as covered by Figs. 7 and 8 now incorporated in Supplement No. 2 to the current tank-car specifications, issued in April, 1936.

[The committee here included eight recommendations regarding detailed changes in Fig. 8, to be submitted to letter ballot. —Editor]

As a result of continued reports of failure of hollow cast-iron plugs in the heads of tank cars, it is recommended that the following new paragraph, to be designated "A. R. A.-16," be included in I. C. C. Specification 103: *"A. R. A.-16. Solid plugs when inserted from the outside must be so indicated by having a raised 'S' cast integral on the face or top of the square head or be otherwise marked 'S' by steel stamp, prick punch or legible stencil, indicating the plug is solid. Plugs inserted from the inside are identified by appearance of the plug on the outside of the tank whether hollow or solid—therefore, no mark or stencil required."*

It is recommended that the foregoing addition to these specifications be submitted to letter ballot of the members for adoption.

Interior Heater Pipes

During the past year applications have been received from builders and owners of tank cars requesting approval of electric-resistance welded pipe for interior steam lines in tank cars. As a result of the study which has been given this subject by the committee, it is recommended that Par. 1 under Sec. G—Specifications for Tank Car Heater Pipes, page 7 of the Tank Car Specifications, be changed in accordance with the proposed form shown below: *Proposed Form:* 1. Heater Pipes and Fittings.—When threaded joints are used, pipes shall be not less than two-inch "extra *strong*" lap welded *steel or wrought iron to current A. A. R. specifications;* or *electric-resistance-welded steel of same diameter and thickness to current A. S. T. M. specifications. When the joints are welded, instead of threaded, to give them substantially the same bending strength as the body of the pipes, the thickness may be reduced 20 per cent.* Joints shall be made by threaded wrought couplings, forged unions, or welding. A minimum number of connections shall be used.

The committee recommends the submission to letter ballot for adoption as recommended practice the specifications for fusion-welded aluminum tank-car tanks for the transportation of non-dangerous commodities as shown in the attached Exhibit A. These specifications have been prepared in co-operation with

representatives of the car builders and the Aluminum Company of America.

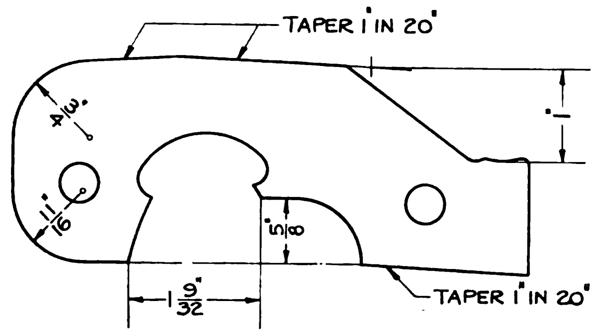
The report was signed by Chairman G. S. Goodwin, assistant to general superintendent motive power, Chicago, Rock Island & Pacific; Vice Chairman F. A. Isaacson, engineer car construction, Atchison, Topeka & Santa Fe; A. G. Trumbull, chief mechanical engineer, Chesapeake & Ohio; G. McCormick, general superintendent motive power, Southern Pacific; W. C. Lindner, chief car inspector, Pennsylvania; A. E. Smith, vice-president, Union Tank Car Company; G. E. Tiley, assistant traffic manager, General Chemical Company; C. C. Meadows, master car builder, Tidewater Oil Company; G. A. Young, head, School of Mechanical Engineering, Purdue University; F. Zeleny, engineer of tests, Chicago, Burlington & Quincy; W. C. Steffa, transportation manager, Sinclair Refining Company; R. T. Baldwin, secretary, The Chlorine Institute, Inc.

Action.—The report was accepted and the recommendations referred to letter ballot. The committee was accorded a vote of thanks for its very complete report.

Wheels

The report includes in Appendix A, a specification for two-wear wrought-steel wheels, having a rim section which conforms substantially to the design of the multiple-wear wheel. This permits measuring service metal with the present standard steel-wheel gage. The tread and flange contour of the two-wear wheel corresponds, therefore, to that of the multiple-wear wheel, and in preparing the drawings, consideration was given to revising the tread and flange contour of the multiple-wear wheel with respect to dimensioning.

Accompanying the report are various revised wrought-steel wheel designs as they appear in the Wheel and Axle Manual and also in the Manual of Standard and Recommended Practice. The report calls attention to the continuance of shelled treads as a cause for the premature removal of wrought-steel wheels from service and says that the best results so far obtained in overcoming this difficulty have been by improved methods of heat treatment.



Minimum flange thickness, height and throat-radius gage for new cast-iron, one-wear wrought-steel and cast-steel wheels

Outstanding changes in the specifications for cast-iron car wheels, shown in Appendix *B* of the report, are designed to provide improved service properties by changes in such details as rim thickness, heat treatment, flange thickness, tape size, and tread and flange contour. The major change in the rim thickness is an increase from 1⅝ in. to 1⅞ in. for 650-, 700- and 750-lb. wheels, and from 1⅞ in. to 2 in. for the 850-lb. wheel. In heat treatment, increased pitting temperatures and controlled cooling of the wheels provide improved physical properties and make possible a more rigid thermal test by increasing the time limit.

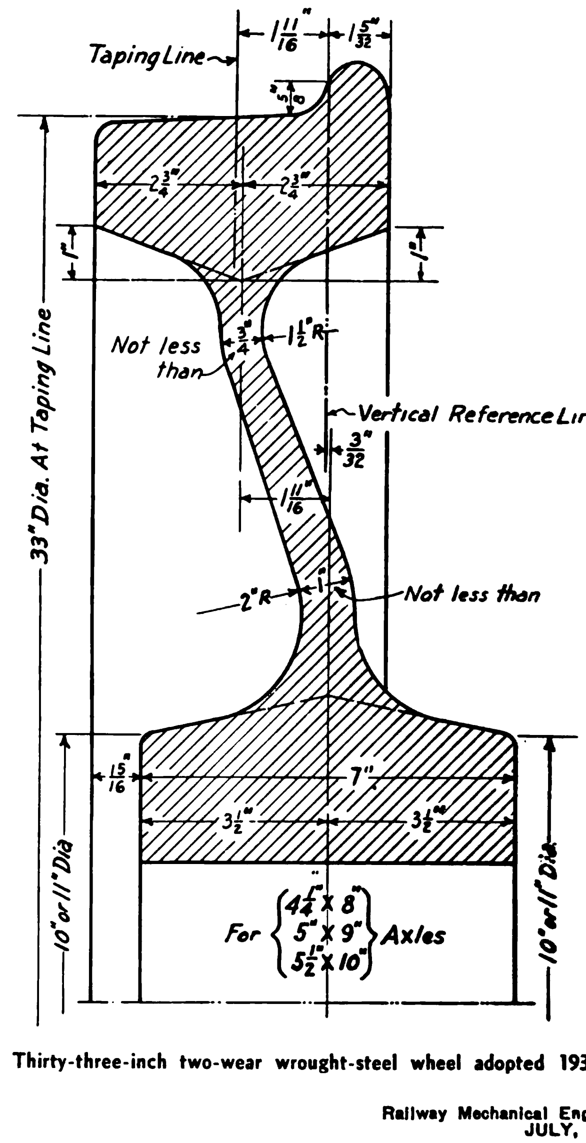
The maximum flange thickness has been reduced 1/32 in. to conform with that of the one-wear wrought steel wheel. A revised method of indicating the tape sizes of new wheels is recommended in order to permit matching wheels to half tape sizes in mounting. A change in dimensions of the tread and flange contour of the chilled-iron wheel is provided to conform with the practice recommended for the wrought-steel wheels.

The report recommends the addition of a paragraph to interchange Rule 71 (owner's responsibility) to condemn flat spots 2½ in. long or over, or two or more adjoining flat spots each of 2 in. in length or over. Certain changes are also recommended to clarify a misinterpretation of freight-car Rule 75 and passenger car Rule 7 (f). The report states that extensive observation of the use of the worn-through-chill condemning gage indicates that it is not fulfilling the requirements, as numerous instances have been observed in which wheels with flattened surfaces condemnable by the gage, are not actually worn through the chill. The report, therefore, recommends certain revisions in Rule 73 and the addition of a new rule 73-A to cover an out-of-round condition. A corresponding revision in the Wheel and Axle Manual is recommended. In Rule 76 covering tread-worn-hollow wheels, it is recommended that the first part of the rule be limited in application to cast-iron wheels and the latter part made to include both wrought- and cast-steel wheels. Also Rule 81 is suggested for revision to include one-wear wrought-steel wheels. Corresponding changes in the Wheel and Axle Manual are recommended.

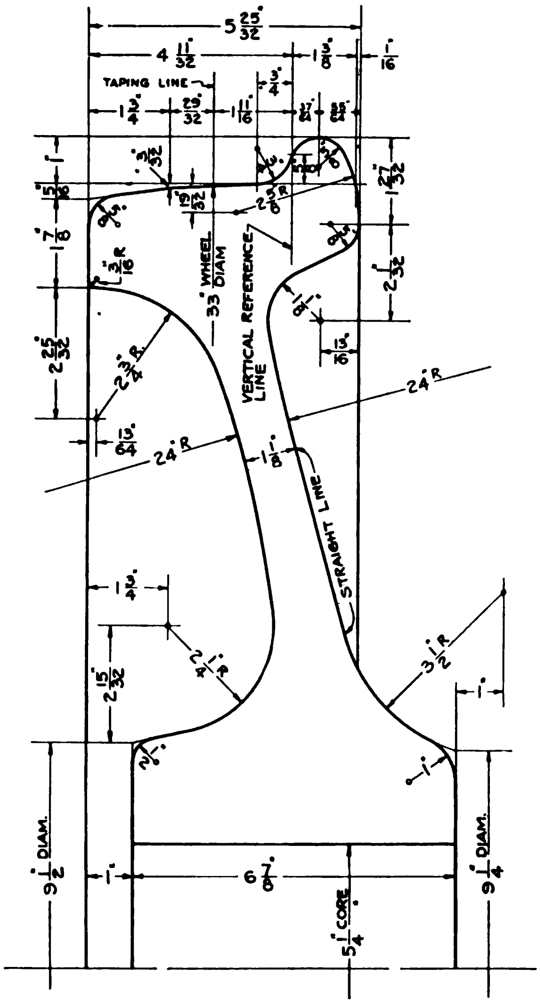
In view of the damaging influence to lading, track and equipment resulting from flat spots on wheel treads at present high speeds the report recommends that consideration be given during the coming year to reducing the condemning limits for slid-flat spots from 2½ to 1½ in. Before making such a drastic change, however, substantial data must be secured to show what the effects will be upon the movement of cars in transit and the removal of wheels for this defect.

The report states that the master gage for use in connection with wheels and axles is practically obsolete and that it will apparently be necessary to develop go-and-no-go gages conforming to construction tolerances for practically each type of standard gage now in use. The report recommends that the I.C.C. Bureau of Locomotive Inspection be requested, through the proper channels, to revise its Rule 145 to conform with the present A.A.R. Rule and permit the same wear limits for cast-steel wheels in locomotive tender service as have been recognized and demonstrated to be perfectly safe for operation in car service.

In closing, the report expresses appreciation for the cooperation received by the committee during the past year from the Manufacturers of Wrought Steel, Cast Steel, and Cast Iron Wheels. Joint conferences held with these manufacturers' representatives have helped advance the mutual interests of the



Thirty-three-inch two-wear wrought-steel wheel adopted 1936



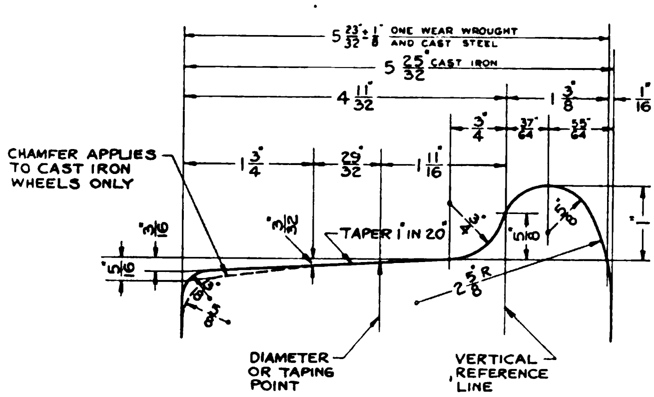
Thirty-three-inch 650-lb. cast-iron wheel for cars of maximum gross weight not to exceed 103,000 lb.

manufacturers and the users of the different types of wheels.

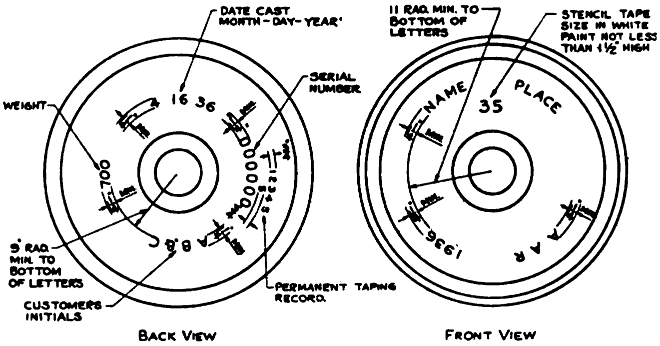
The report was signed by Chairman R. G. Henley, superintendent motive power, Norfolk & Western; Vice-Chairman F. W. Hankins, chief of motive power, Pennsylvania; C. J. Bodemer, superintendent machinery, Louisville & Nashville; F. H. Hardin, assistant to president, New York Central; J. Purcell, assistant to vice-president, Atchison, Topeka & Santa Fe; and J. J. Tatum, general superintendent car department, Baltimore & Ohio.

Discussion

J. E. Mehan (Chicago, Milwaukee, St. Paul & Pacific) raised a question regarding the necessity of restricting ground wheels to system cars as recommended in the report. Mr. Coddington replied that the privilege of grinding car wheels had been greatly abused; that portable grinders were still being used in certain instances. The committee feels that the restriction is necessary. J. McMullen (Erie) said that if wheels wear out

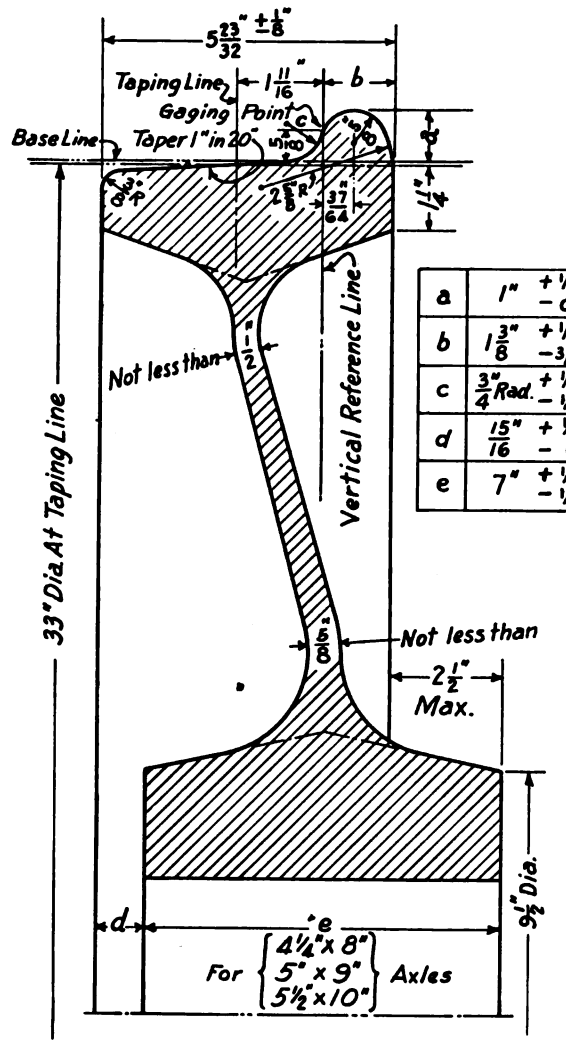


Tread and flange for cast-iron, one-wear wrought and cast-steel wheels adopted 1936



When taping the wheel, numerals will be chipped off as follows: Tape 1, chip no. 1 numeral; tape 1.5, chip no. 1 numeral and the underneath no. 5 numeral; tape 2, chip no. 2 numeral; tape 2.5, chip no. 2 numeral and the underneath no. 5 numeral, etc.

of round, it must be on account of a defective chill and that therefore he doubts the advisability of attempting to reclaim such wheels by grinding. J. W. Burnett (Union Pacific) asked if the committee is investigating the subject of cylindrical versus taper tread wheels, and was informed that wheels of the cylindrical tread type are now under observation but the committee has nothing to report at the present time. H. W. Faus, engineer of tests (New York Central) said that this subject pops up once in every generation and that an examination of the record shows that cylindrical tread wheels have been tried in the past many times and discarded. To make sure that it is not overlooking a bet, Mr. Faus stated that the New York Central has recently made tests of two standard coaches with four-wheel



One-wear wrought and cast-steel wheel adopted 1934 —Revised 1936

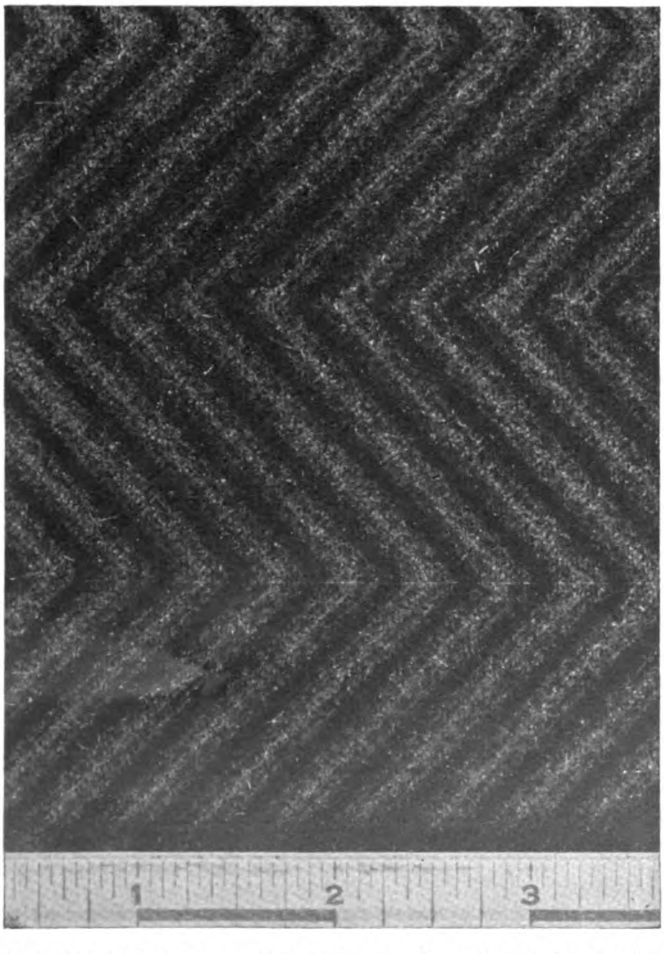
trucks, one equipped with cylindrical tread wheels in comparative service, and definitely shown that for this type of equipment at least the cylindrical tread wheels are detrimental rather than beneficial. R. L. Kleine (Pennsylvania) stated that his road has 20 multiple-unit cars equipped with cylindrical tread wheels in test service and expects to obtain some definite information regarding comparative performance within a short time. Lawford Fry (Edgewater Steel Company) said that equipment design and roadbed conditions both have a bearing on the question of what type of tread should be used and that experience has shown certain advantages for cylindrical tread wheels on relatively light multiple-unit equipment.

Action.—The report was accepted and referred to letter ballot.

Lock-Tite Mohair Velvet Upholstery Fabrics

A line of mohair velvet upholstery fabrics for use in railway coaches and other transportation equipment has been developed by the Collins & Aikman Corporation, New York. These fabrics possess unusual qualities because of the special type of construction employed. The mohair pile is locked in the foundation fabric by impregnating the latter with a Latex compound. This makes it possible to increase materially the density of the pile and seals the fabric against the penetration of dust. The dense pile can be cut low and stands straight out so that there is no change of sheen with a change in the direction of the source of light on the surface.

A large range of patterns and color combinations comprise this line of fabrics. The designs range from the classic chevron to shaded checks and wavy plaids. A number of florals are also available. A variety of pattern and color combinations are achieved by the use of plain dye base colors by which the patterns are printed in suitable color combinations. Patterns in woven colors are also available.



Chevron motif in three shades of the color selected—The velvet photographed is peacock blue

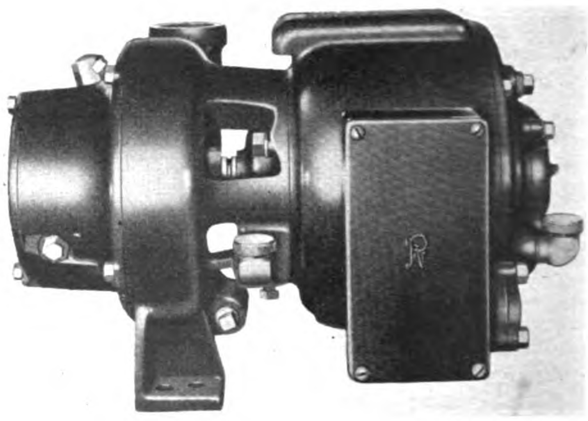
Improved Headlight Generator

A development in headlighting equipment recently announced by the Pyle-National Company, Chicago, is designed to meet the more exacting requirements of modern high-speed train operation. This equipment employs a new principle of alternating current generator construction and the use of a low-voltage headlight lamp with a concentrated filament that is said to produce fully three times the headlight beam intensity obtained from present type headlight bulbs. The a.c. turbo-generator provides the low voltage for the headlight and standard 32-volt current for the cab and auxiliary lights.

The turbine is a standard Pyle-National type provided with stainless steel valve and cage, drop-forged turbine wheel with nickel-alloy blading and a sensitive positive governor control. The rotating element is provided with ball bearings of liberal size, lubricated by the Pyle-National system of controlled circulation.

The omission of armature windings, commutator, collector rings and brushes in the alternating-current generator reduces maintenance and inspection to a minimum. The regulation is said to be equal to that of compound direct current machines.

The installation of this equipment involves only slight changes in present headlight cases. When the low-voltage lamp is used the energy is supplied by the machine through a transformer located in the headlight case.



Pyle-National alternating current turbo-generator

The lamp stand is a permanently-adjusted type which eliminates focusing uncertainties when lamp replacements are made.

The alternating current turbo-generator can be used with present 32-volt headlights without change. However, when low voltage headlighting is required, a transformer is installed at the case, the lamp mounting device is exchanged and the opening in the reflector made larger to accommodate a prefocused socket.

The machines are available in a range of sizes, to meet all locomotive headlighting conditions and are adaptable to train control service.

EDITORIALS

High Lights of the Convention

The meeting of the Mechanical Division of the Association of American Railroads, held in Chicago, June 25 and 26, which was preceded by a meeting of the General Committee, was well attended. Each of the standing committees of the Division has been in existence for many years, has well-defined objectives, and there is little change in the committee personnel from year to year. As a result, the reports deal largely with details relating to improvements in the present standards and recommended practices. Positive recommendations are made only when the facts clearly indicate the wisdom of the action to be taken. Where new or radical elements are interjected because of changing conditions or the introduction of new materials and designs, such facts as are available are reported upon, but action is not recommended until sufficient data have been assembled upon which to base sound judgment. As a result, there is not as much opportunity for heated discussions as was true in the earlier days of the association, when the standards and recommended practices had not reached so advanced a stage.

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There are few opportunities for dramatic presentation and at only one time during the two days of the meeting did the discussion approach the dramatic. The Committee on Car Construction, with the co-operation of the Design Committee of the American Railway Car Institute, has made an excellent job, at the expenditure of considerable time and money, in designing A.A.R. box, auto box and hopper cars. Unfortunately the railroads as a whole have not taken advantage of these standard designs to as great an extent as had been hoped for.

The design for the box car was submitted in 1932 and yet in 1934 only about one-third of the cars ordered followed the A.A.R. standards completely, or even extensively. An even smaller percentage of A.A.R. box cars were among those ordered in 1935. Chairman Kiefer of the committee, in presenting the report, frankly challenged the Division and said that unless the members of the A.A.R. intended to follow these standards, it would be futile to attempt to establish other standards. Members of the committee have heavy responsibilities on their individual railroads and cannot afford to give the time to the development of standard cars, unless the railroads seriously intend to follow these standards.

Representatives of a number of railroads spoke highly of the work of the committee, urged that its program be continued, and indicated that they were using the standard designs. Representatives of roads not following the standards discreetly kept in the background and no explanation was given for the lack of support for the A.A.R. designs. Apparently, however, the response to the committee's challenge, and the action taken, were such as to encourage the committee to continue work on its program.

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At the afternoon session on Thursday, Chairman Garber read a statement from the General Committee, urging that the younger members of the Association take a more active part in the discussions. Vacancies occur on the standing committees of the association and, said this statement, "it is difficult for the chairman of the General Committee to select men for these responsibilities unless he knows their ability to handle the job satisfactorily. There is no way for him to find out who is qualified unless they get up and discuss the subjects that are brought before the association."

A glance over the audience, however, indicated that few, if any, of the young men were in attendance. Two of the younger men in the audience did take part in the discussion, but they have done so at previous conventions and undoubtedly intended to do so at this one. Both of these young men, however, are in their late thirties, one of them being born March 14, 1899, and the other January 25, 1897.

Let us hope that as business conditions improve the railroads will find it possible to send the young men in their organizations to these annual meetings. They are a great training school and there is little question but what the investment in sending them to such meetings will pay many times over, if the young men are properly selected and coached.

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A feature of the first session of the meeting was the so-called "pep talks", entirely aside from the regular program of the convention. The speakers included Assistant Chief Shirley of the Bureau of Locomotive Inspection of the Interstate Commerce Commission: L. W. Wallace, director of the Equipment Research Division, A.A.R.; and Roy V. Wright, editor of the *Railway Mechanical Engineer*. These talks, all of an intimate, extemporaneous character, generally touched upon subjects of deep interest to the mechanical department officers, but not necessarily related to matters of standards and recommended practices. Mr. Wallace made clear the objectives of the department of which he is the head and indicated how it could work with and be helpful to the Mechanical Division committees.

One of the speakers also placed emphasis on the importance of the human problem, in that special efforts must now be put forth to train skilled workers and to

develop men for supervisory and executive positions in the mechanical department.

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Samuel Lynn, chairman of the Committee on Loading Rules, indicated when the very complete report of that committee was made a year ago, that there would be little if anything to suggest in this year's report. As a matter of fact, the printed report contains 67 pages, the larger part of it, however, being used for tabular material in connection with the spacing of bearing-pieces on flat cars. Mr. Lynn did indicate, however, that special efforts were being made to modify the rules as much as possible, in order to cut down the costs to the shippers. Safety is the chief requirement and must never be lost sight of. On the other hand, where the requirements are in any way excessive, unnecessary expense is placed upon the shipper, which may make it advisable for him to consider the use of other forms of transportation. The committee has had splendid co-operation from the shippers in making studies and experiments with a view to modifying the rules toward this end.

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One cannot but be impressed by the extent to which organizations or groups of railway supply manufacturers co-operate with the committees of the Mechanical Division in the preparation of their reports. Several times during the discussions of the reports announcement was made that the representatives of different supply interests would have the right of the floor during the discussion of a report in which they were specially interested. This was not taken advantage of in very many instances because the technical experts in these various groups had little to add to the information and data which had been furnished to the committees. It was quite obvious, however, that where they did take part they were listened to with keen attention and their co-operation was highly appreciated. The technical experts of the railway supply companies are in possession of information and have had experiences which make their findings invaluable to the association.

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While the matter did not come before the convention as a whole, there is little question but what, if business continues to improve, a more elaborate convention program will be scheduled for next year, including an exhibit by the Railway Supply Manufacturers' Association. President Sidney G. Down of that organization spoke briefly at a luncheon which the Executive Committee of the R.S.M.A. gave to the General Committee of the Mechanical Division on Wednesday, the day before the convention. He indicated that the expense of such an exhibit was, of course, a large item. On the other hand, it does make it possible for the railway supply companies, at a minimum expense, to demonstrate their equipment and new devices to the mechanical department representatives.

The railway supply companies, hampered by the same lack of business as the railroads, have not had the opportunity that they formerly enjoyed of bringing their devices to the attention of the railway officers. An exhibit with a large attendance at a convention would enable them to do this and at the same time would be a liberal education to the supervisors and officers who have been appointed in recent years and to the more ambitious younger men who will advance to positions of authority.

The railway supply men, in talking among themselves, feel that they can make the exhibit almost a small university from an educational standpoint for those who wish to take advantage of it, and plans will undoubtedly be made toward that end, if business conditions next year are favorable. The new materials which have been developed in recent years promise to revolutionize designs in many respects. Higher speeds and highly competitive conditions in the railroad field make it necessary for the railroads to take advantage of every possible opportunity to reduce the weight of the equipment and make it more efficient and economical in operation.

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The spirit of the convention was saddened by the fact that W. G. Black, vice-president in charge of the mechanical department of the Van Sweringen Lines, who was to have been elected chairman of the Division, passed away on the Saturday prior to the meeting. His death came as a distinct shock to the members, who regarded him highly because of his ability and his constructive efforts in the interests of the Division. Parts of the report of the Committee on Locomotive Construction were prepared by S. S. Reigel, former mechanical engineer of the Delaware, Lackawanna & Western, who also passed away recently.

Locomotive Failures

Failures of either cars or locomotives in service are not only expensive—sometimes extremely so—but delays or damage to persons or goods cause much irritation and criticism. Good will on the part of the public toward the railroad is an asset which must be assiduously cultivated and jealously guarded.

The only way to reduce failures to a minimum is exhaustively to examine into each individual failure, and, like the G-Men, track it down determinedly and unremittingly to its primary cause, no matter how apparently insignificant it may be. Some railroads have made splendid progress in reducing failures by such methods, following up, of course, by changing the practices or designs to eliminate the sources of trouble. Sometimes the investigations led into odd and unanticipated places.

In recent months we have published several articles on Locomotive Failures by Fred H. Williams of the Canadian National Railways. Just as the G-Men have specialized to a high degree in the tracking down of

public enemies, he has specialized in running down failures of locomotives and rolling stock. The compound microscope and other special devices have been drafted for his use.

There are men in the medical profession who specialize in making physical examination and diagnoses. They search for the causes of our physical ills and then turn us back to the family physician or a specialist for treatment. Mr. Williams is doing much the same thing in locating the weak spots and sources of trouble with cars and locomotives. Once tracked down, they are then referred back to the designer, maintainer or operator for correction.

Thus far in his studies of locomotive failures—side rods and driving wheel tires—he has taken some pointed shots at the back shop in its machining practices. Is he right? What have the shop men to answer to these indictments? Are his points well taken or would a trial before an impartial judge and jury find the back shop guiltless? Can such insignificant details as he has pointed out be responsible for such disastrous results? If he is right, is it because of lack of proper facilities or equipment in the back shop and engine house? What is your opinion?

Standardize Lubricants

While not so specifically stated, the inference to be drawn from the discussion of railroad lubricants at the railroad session of the spring meeting of the American Society of Mechanical Engineers at Dallas, Tex., seems to be that pet theories and fads incorporated in the specifications are costing the railroads a lot of money. If the different railroads would waive some of their peculiar requirements in the specifications for freight-car lubricants, for instance, and would agree upon a common standard, a considerable cost in producing and carrying in stock a variety of oils would be eliminated.

According to the experts, and they apparently base their conclusions on thorough investigation and research, there is little, if any, difference in the practical lubricating qualities as between the great variety of specifications now insisted upon by the different railroads. Moreover, it is claimed that an oil suited to either summer or winter temperature conditions can be produced which will prove little if any more expensive than the present oils—possibly less so because of producing and carrying in stock only one variety.

There are few questions of greater importance to the railroads than this problem of lubrication for cars and locomotives. Much scientific study and research have been carried on in this field by the oil producers and distributors, since the railroads are among their largest customers. It would seem that the research division of the Association of American Railroads could render a large service by fostering cooperative endeavor between the oil interests and the railroads in developing common standard specifications for lubricants, and in educating the railroads to the value and importance of adopting and supporting such standards. Fads and fancies now incorporated in some of the specifications are too expensive and troublesome to be tolerated in these days when there seems to be strong evidence that they do not make for increased efficiency or economy.

There are no other phases of the lubricating problem which are also of prime importance. Special attention should be given to improving the design of the equipment to insure the more effective application of the lubricants, and also in training the forces in the best methods and practices for their efficient use. With higher train speeds and more intensive use of the equipment these matters are of extreme importance.

NEW BOOKS

ELEMENTS OF DIESEL ENGINEERING. *By Orville Adams. 450 pages, 6 in. by 9 in. 284 Illustrations. Bound in cloth. Published by Norman W. Henley Publishing Co., 2 W. Forty-Fifth St., New York.*

In this volume, prepared by a consulting Diesel engineer of wide experience in the field, the reader is offered a textbook which covers in detail the current applications of Diesel engines from the fundamental principles of design and operation to the actual maintenance and repair problems met with by the operating engineer. The twenty chapters of the book cover seven major divisions of the subject; viz, History of Diesel development; elements of Diesel operation and definitions; fuels, fuel-injection systems and combustion; engine construction, maintenance and lubrication; Diesel development, with particular reference to high-speed engines such as used in railway service; operation and maintenance of automotive Diesels, and field maintenance of automotive Diesel auxiliaries and accessories. A feature of this book, which should appeal particularly to one interested in a study of Diesel engines is the fact that each chapter is accompanied by a complete group of questions and answers—over 300 in the entire volume—which discuss fully the important points in the text. Illustrations and diagrams covering working parts and the construction and operation of all major classes of Diesel engines are generously provided.

PROCEEDINGS DIVISION V—MECHANICAL, *Association of American Railroads. Published by the Association, 59 East Van Buren Street, Chicago. 1,090 pages. Price, $5 to members; $10 to non-members.*

The proceedings of the Division V—Mechanical just issued by the Association of American Railroads, Operations and Maintenance Department, for the session held at the Congress Hotel, Chicago, June 26 and 27, 1935, contain also recommendations, letter ballots and other transactions for the years 1933 and 1934, during which years no member meetings were held because of prevailing business conditions.

THE READER'S PAGE

Largest Fireless Locomotive

To the Editor:

With regard to Mr. LeFevre's letter concerning fireless locomotives in the *Railway Mechanical Engineer* of April, 1936, it may be of interest to note that in 1924 the Baldwin Locomotive Works built an 0-6-0 fireless locomotive weighing 171,790 lb., for the Dallas Terminal Warehouse of the Gulf, Colorado & Santa Fe Railway. This engine must be very nearly the largest of its kind.

William T. Hoecker.

Can Match Walt Wyre

To The Editor:

I get quite a kick, so to speak, out of the Walt Wyre stories about the troubles and headaches of the Plainville outfit; also the comments on these stories by your readers.

I fear the critics, or most of them, take the yarns as everyday happenings and forget that Walt Wyre has only one story a month. On the other hand, from experience I would suggest that if Jim Evans and the others at Plainville only have one bad day a month, they have good reason to pat themselves on the back and feel lucky.

I am employed at a small junction where most of the trains have work to do. Some start and end trips here, and some turn. In all, we have about 40 trains every 24 hours. The yard is only about 45 cars long, but some of the trains have about 100 cars. Eastward they all go out on one line; westward on three lines. If I were good with a pen I could easily write a headache story at least once a week about some of us at this point, that would equal Walt Wyre's Plainville yarns.

Block Operator.

Back Shop Foreman Speaks

To the Editor:

Recent issues of the *Railway Mechanical Engineer* have had many articles commenting on the trying conditions under which the enginehouse foreman labors.

We of the back shop will agree that twelve hours is too long for any foreman to work, day after day. During the past depression, when the back shops were closed down, the foremen were laid off and at times were actually in dire need. At the same time the enginehouse foremen were drawing fair salaries and they did not complain about any over hours. Of course, they felt sorry for the foremen of the back shop, but they did not offer to put out a helping hand. Now that conditions are better, every department is working normal and the hard worked enginehouse foremen seem to want to vent their feelings.

The back shop foremen could tell a lot about meeting strenuous conditions and how, in an effort to help them out, they have handed over time after time to the enginehouse foremen, parts which have been assembled on their outgoing engines.

Let's hear from some of the back shop foremen. These enginehouse foremen are no harder pressed and do not work under pressure any more than you do.

We asked for work, we are getting it, and we enjoy the urgent demand for power. Here's hoping it keeps up! Let them bring on the work; we of the back shop can take it standing up!

Back Shop Foreman.

Heat-Treated Tires and Truck Wheels

To the Editor:

Recently another problem has been added to the machine shop foreman by the adoption by the railroads of what is called "heat-treated tires and truck wheels." It seems that as soon as the metallurgists develop some better grade of tool steel, the material manufacturers go them one better and manufacture harder materials.

Possibly some of your readers could give the rest of us useful information pertaining to the machining and mounting practices. In our shop it has been found necessary to change all previous practices, both in machining and in pressure allowances. With the old type truck wheel, 12 to 14 were bored in an eight-hour day on a car wheel boring mill using a Davis boring bar, at a speed of 30 ft. per minute, .125-in. feed for roughing and .180-in. for finishing. No difficulty was experienced using a good grade of high-speed steel.

There appears to be a wide variation in the hardness and toughness of the bore in the heat-treated wheels. By reducing the speed to around 20 ft. per minute some can be bored without any difficulty; on others, even with the best grades of cutting steels now available, it is extremely difficult to get a smooth, true and parallel bore. Recently, out of four wheels, two were bored with high-speed steel at a speed of 20 ft. per minute, .062-in. feed and were within .001 in. of being straight and parallel, although it took several cuts to secure this accuracy. The other two were roughed out the same way, but because the tool wore so fast we could not get a straight bore.

Five different makes of high-speed steel were used, with practically the same results, and, as a last resort, we tried a tantalum-carbide tool bit, which, with light cuts and feed, eventually got a satisfactory finish.

For pressure-fit allowance we used—previous to the heat-treated wheels—a formula of .001 in. to the inch diameter of the bore, which would give the tons pressure required. To get the same pressure with heat-treated wheels we have found that only about half the allowance is required, depending on the hardness of the metal. On the four wheels previously mentioned—the bore was 8 in. diameter—.004 in. was sufficient allowance for the two hard wheels, but on the two softer ones, .005½ in. was required to give the same pressure.

May we not hear from other shopmen on this subject?

Machine Shop Foreman.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Open the Flood Gates

Your editorial, Open the Flood Gates, sure made a hit. Some of the comments which I overheard other readers make included, "That sure hits the nail on the head"; "That certainly applies to persons that I know of"; etc.

A Sound Pension System

If your paper could advocate a pension for railroad men to be handled by the railroad companies themselves, I think it would be preferable to the present plan. My suggestion is that the railroad and the employees get together and have each pay a certain proportion each month to a pension fund that will cover all employees; each railroad to handle its own pensions independent of any government interference.

Welding Tires

You occasionally publish photographs or particulars of failures which have taken place, such as the photograph of a broken tyre, which appeared on page 51 of your issue for February, 1936. It is interesting to find that a breakage has actually taken place due to welding tyres, as the possibility of this occurring has, so far, deterred us from using this method of building up flanges. The process would be a very economical one, having regard to the amount of tyre which has to be turned away to restore the flanges to their proper thickness.—*From an English Reader.*

French Engine Drivers

Also, and this is important, a French engine driver is an artist at his work. He just does not climb into the cab, pull the throttle and let her go. From the moment that he starts his locomotive, until the end of the run, every minute of the time he is on his job working, studying, maneuvering his engine to get the very most out of it and save his fireman. They give him the necessary instruments and he can watch and knows exactly what is going on from throttle opening to exhaust tip. A great deal of the fine results obtained is due to the way the French engine driver operates his engine.

What Is a Car Foreman?

In the April issue I notice a contribution signed "Car Foreman." As a back-shop man during the past 25 years, I have occasionally heard the expression "car foreman," but I have never actually come in contact with one, nor ever heard just what they are, or how they got that way, or where they come from, or what they do. Perhaps I may be wrong, but if I ever have given the matter any thought at all, I have supposed their main job was to sign the work tickets of those men who run up and down, hitting car wheels with hammers every time a train stops at a depot. Perhaps I am mistaken. Will you please let us locomotive shop men know more about what a car foreman is?

Safety Devices Pay Well

It seems to me that all railroads contemplating a program of locomotive improvements when the prosperity corner is reached would do well to consider safety devices as well as speed producing and tonnage boosting equipment. Most of us can hark back to the days when the work of installing the water column and second water glass was carried out, and there is no question but that the water column is a proven safety device that has paid for itself many times over and has been a contributing factor in the decrease in the number of low water accidents during the past few years. And now it should be apparent to all thinking railroad men that every modern locomotive should be equipped with proven boiler safety devices. According to this enginehouse foreman's way of thinking, the railroads have reaped the largest dividends from their investments in safety.

The Fuel Bill

Greater space should be devoted to the item that costs the railroads the most money—the fuel bill. There is hardly an operation of the railroad that does not find its way into the coal account. If the car repairer in the shop puts on a brake shoe that touches the wheel and causes some friction, it is contributing its small part to the heavy pulling of the train, which takes more coal. When the conductor or flagman gets to the train a few minutes late, account of waiting for the bill or some other reason, the engine has to make up this time, and to do this, burns more coal. This is so on down the line, and when the final bill is rendered it is a tremendous expense. The steam locomotive, at its best, is a crude piece of machinery, although the most economical means of power we have to date, and no doubt, will be with us for a very long time; so in view of the ever increasing prices for coal, this is a subject that could be dealt with every month. If we can hammer at the subject long enough to get everyone thinking, there can be tremendous savings and better performance.

Haste May Make Waste

A bright young machinist, recently out of his time, was placed on the 90-in. tire turning lathe, the regular operator being off because of illness. At the end of the first week I said to him, "Bill, you are not getting out as many tires as old Joe did."

"No, sir," he replied, "I am not, but I'll bet you that the tires I do turn out are not going to cost you as much in the long run."

"How come, Bill?" I asked.

"Well," he replied, "these 66-in. heat-treated tires cost about $100. each. They are 3½ in. thick and are scrapped when they are worn to 2-⅜ in. Is that right?"

"Yes, go on."

"Well then, each 32nd of an inch of what you use costs you about $2.75, just doing the calculation in my head."

"Go on. What about it?"

"Well, if I get in a great hurry and try to do a pair an hour as I hear they do in some shops, and in so doing take off only 1/32 of an inch more than is absolutely necessary, the whole set of eight tires would have about $22. worth of good tire wasted. These fast records cannot be made without getting the tool well under the scale or low spot, and it is quite easy to take off as much as 1/16 of an inch too much if you are only thinking of speed and how many tires you can turn in a given time. Fifteen minutes of extra time per pair is, I believe, well spent, don't you?"

"Where did you learn all this stuff?" I asked.

"Oh, in the classroom, before I was out of my time."

"Well, Bill, you may be right. I am going to check it up."

Now, what in heck am I going to tell Bill?

Failures of

Locomotive Parts*

By F. H. Williams†

TIRES like shoes wear out in time, but there are some that come to an untimely end. Such failures result from several causes and may range from new tires to those that are worn near the limit. In this article only one class of failures will be considered—those due to "transverse" tears of the metal caused by rough machining of the bore of the tire. In contradistinction to the marks of the cutting tool in the direction of the cut, gobs or hunks of metal are torn out in the roughing cut, which leave pits or tears at right angles to the line of the cut. These may be classed as transverse tears.

In boring a tire the roughing cut is followed by a finishing cut. Much depends upon both of these operations. If in taking the roughing cut the metal is badly torn, the damage done may not be removed by the light finishing cut and the tire may fail in service.

An examination of Fig. 1, which is an enlarged view of the bore of a tire that failed, will indicate that the metal was rather badly torn in making the cut, resulting in the so-called transverse tears, pieces of metal being gouged out. The effect of this may be illustrated in an exaggerated way by considering a rather unusual

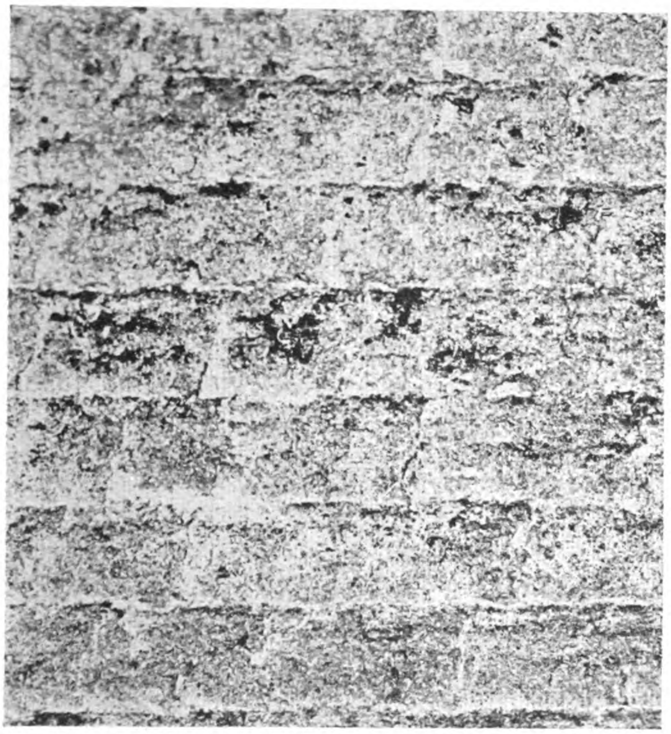


Fig. 1—Greatly enlarged view of the bore of a tire that failed because of rough machine finish

experiment. Tests have proved that a polished finish on a test piece will prevent failure under impact at -70 deg. C., but the slightest tool mark in the test piece will cause it to fracture like glass at the same temperature.

The bores of tires vary as to contour. The more angles or edges there are, the more danger spots if the work is not properly done. Sharp corners should be avoided. Rounded edges and fillets should be used with a smooth finish. Tools must be kept properly sharpened and the light finishing cut should remove all tears made by the roughing tool. Such tears, especially on the edges, may cause fatigue cracks. Even small fatigue cracks, 1/8 in. deep, will cause the tire to break, and this may mean considerable damage to rolling stock and perhaps loss of life.

With this introduction, let us examine some typical photographs that clearly illustrate the damage caused by lack of proper machining.

A section of the inside of a tire which was machined with a coarse feed, the tool not cutting freely, is shown in Fig. 2. Tears in the metal can be plainly seen in several places, especially near the counterbore (the darker section), which itself has a rough and torn surface. Part of the bore, particularly near the bottom of the photograph, is fairly smoothly finished. The fatigue crack started at X, Fig. 2, as is clearly shown in the lower left-hand corner of Fig. 3, just at the edge of the counterbore. The nucleus of this fatigue crack, however, is about half the width of the fatigue crack from the edge of the counterbore; as indicated in Fig. 2, the metal was badly torn at this place. It will be noted that the fracture radiates from the fatigue crack like a sunburst, and it is therefore safe to conclude that this failure resulted from the fatigue crack, which in turn originated in that part of the bore of the tire where the metal was badly torn by improper machining.

The finish of the bore of the tire shown in Fig. 4 is finer than that shown in Fig. 2. It will be noted, however, that cross tears are quite apparent, particularly on the side opposite the counterbore (the upper part of the photograph). It was here that the fatigue crack started, as is indicated by the dark spot at X, in the photograph of the cross section of the broken tire, Fig. 5.

Fig. 2—View of inside of tire; dark section at top is the counterbore. Fatigue crack started at X because of tears in metal by rough machining. Fig. 3—Fatigue crack at X started from rough finish shown in Fig. 2; fracture radiates from it like a sunburst. Fig. 4—This finish in the bore of the tire is somewhat finer than that shown in Fig. 2. Fatigue crack started at X. Note the tears in the metal. Fig. 5—Cross-section of fractured tire, the machine finish in the bore of which is shown in Fig. 4. Fatigue crack nucleus at X. Fig. 6—Shows machine finish in bore of tire which was fractured in several places. This finish is fairly smooth, as compared to previous illustrations. Fig. 7—This small fatigue crack in the tire, the machine finish in the bore of which is shown in Fig. 6, started at the sharp corner. Note the sunburst effect in the fracture. Fig. 8—Another fatigue crack in the tire shown in Figs. 6 and 7; not at the sharp corner in this instance. Fig. 9—This tire, with its rough finish in the bore, broke in nine places, four of the fractures showing well-defined fatigue cracks

* Part III of an article which began in the May issue.
† Assistant test engineer, Canadian National Railways.

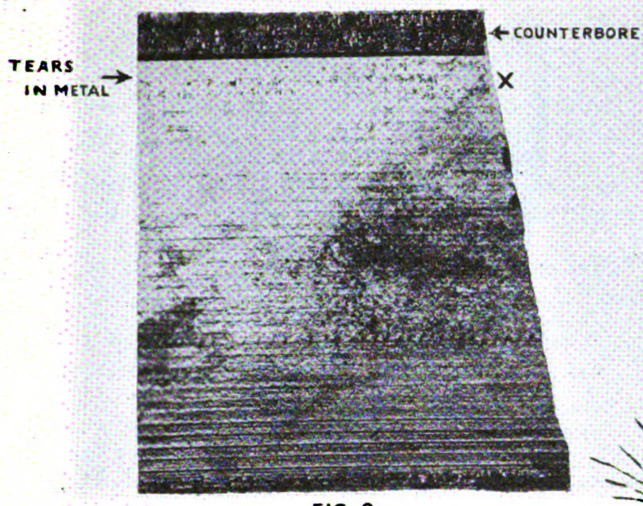


FIG. 2

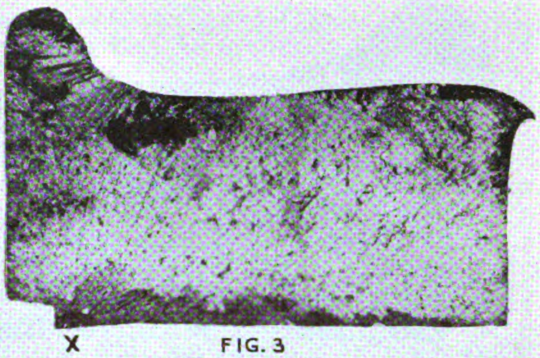


FIG. 3

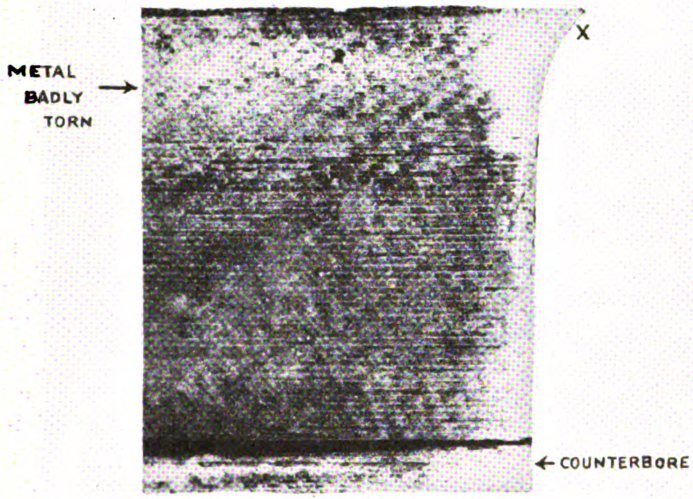


FIG. 4

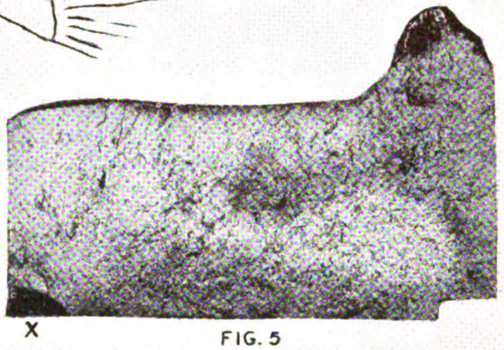


FIG. 5

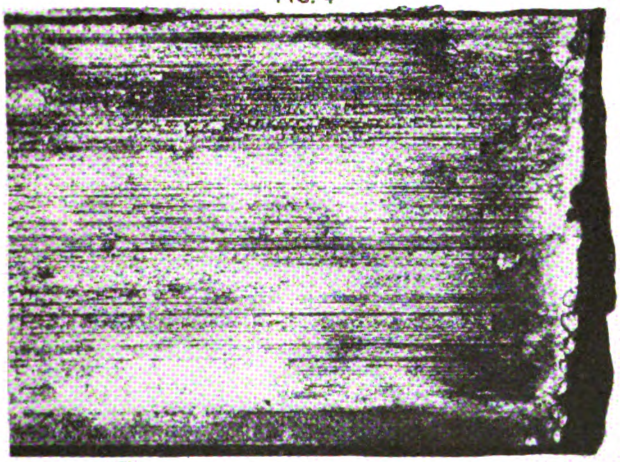


FIG. 6

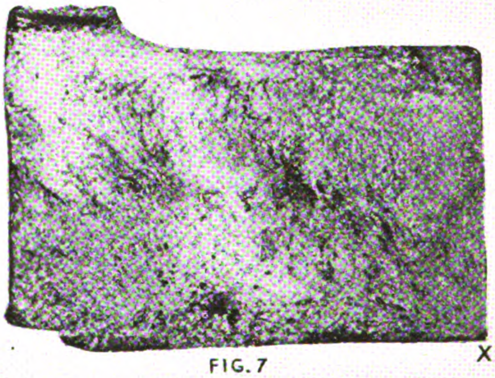


FIG. 7

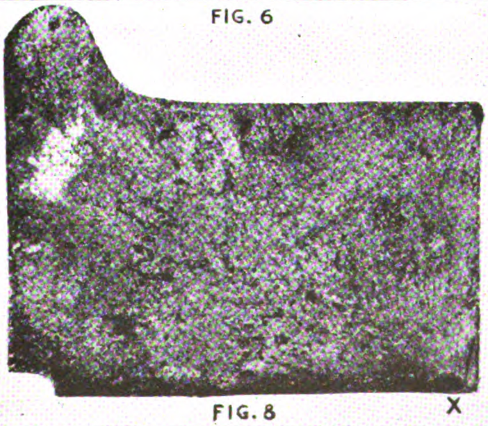


FIG. 8

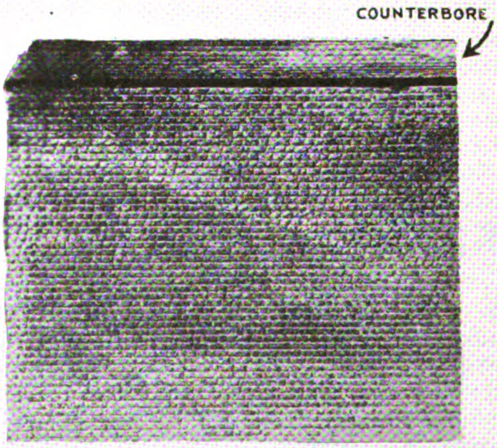
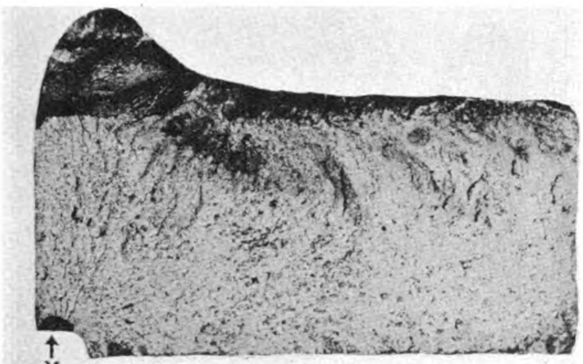
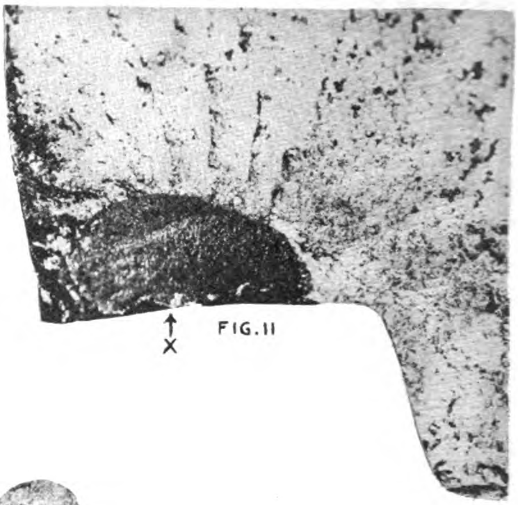


FIG. 9



↑
X
FIG. 10



↑
X
FIG. 11

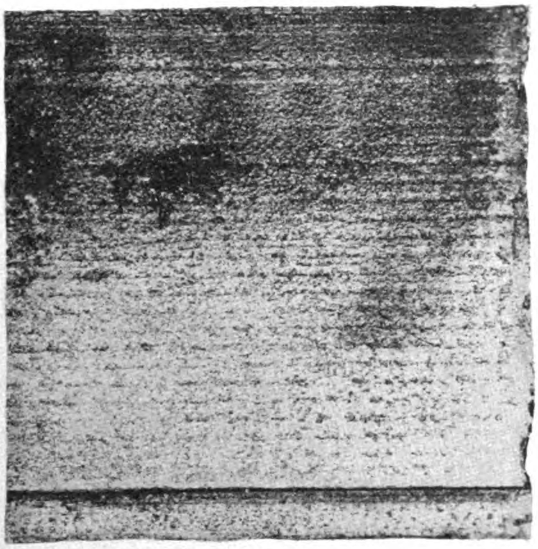
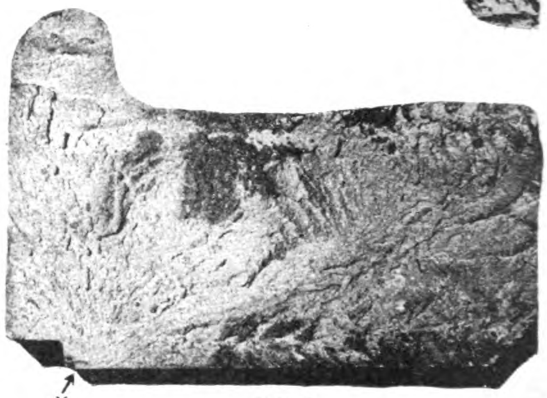


FIG. 12



X
FIG. 13

Fig. 10—One of the fractures in the tire, the machine finish in the bore of which is shown in Fig. 9. The fatigue crack in this instance started in the counterbore. Fig. 11—Enlarged view of fatigue crack shown in Fig. 10. Fig. 12—Another example of rough machine work in boring a tire. The roughness is smoothed somewhat by corrosion. Fig. 13—This fatigue crack may appear insignificant, but it caused the tire to fracture. The machine finish of the bore is shown in Fig. 12

It should be noted, also, that this edge of the bore was quite sharp. The possibilities of a fatigue crack originating in this point might have been lessened had the sharp corner been rounded off. In this case this may not have had anything to do with the origin of the crack, however, since the nucleus on critical examination appears to be about 1/4 in. from the edge. There is little question, however, but that the crack originated from a tear caused by rough machining. The lines of fracture radiate faintly from the fatigue crack, and not quite in such a pronounced fashion as in Fig. 3. The fatigue crack was corroded, but there is no way in which to ascertain the length of the period over which the crack developed. It is quite possible, for instance, that such a crack may start in the summertime, but actual failure may not take place until severe weather in the following winter.

A photograph of the bore of a tire that failed in several places is shown in Fig. 6. This is a fairly smooth finish, compared to the previous illustrations. In addition to the roughness, however, the edges of the tire are sharp, no attempt having been made to round them off. The tire was fractured in at least two places, each originating in a fatigue crack. One of the fractures, which started in the sharp corner with a very small fatigue crack, is shown in Fig. 7. There are fairly clear indications of a sunburst from this point.

The fatigue crack for the other fracture is shown at X in Fig. 8. It will be noted that the usual radiating lines extend from the fault, clearly pointing out the culprit. This was almost a new tire and the bore was fairly satisfactory as to quality of finish, except that it was not good enough. It strongly emphasizes the importance of better finishes in the boring of tires.

How to Insure Better Finish

I have heard that some railroads are resorting to grinding the bores of tires. This sounds reasonable, especially if it is not possible to secure a suitable finish otherwise.

One of our major shops is rough boring with a 3/8-in. feed, two tools cutting 3/16 in. each. A finishing cut is then made with a tungsten carbide or similar tipped tool, at the rate of 150 ft. to 250 ft. per min. This gives a finish free from transverse cracks. The surface is almost like glass; indeed, a kid glove would not be torn, rubbed either with or across the faint tool marks. It seems to me that this is the solution of tire boring. The operator, however, must be on the alert. A properly used tool will finish from 300 to 400 tires, but a careless operator can destroy one in a moment of forgetfulness. If such a tool is not allowed to complete the circumference on the last turn, it is ruined; this, however, furnishes a positive check on the complete finish of the bore. A tire can be bored in about 20 min. by this method. It is thus quicker than grinding and just as satisfactory, if not better.

Another example of a rough finish of the bore of a tire is illustrated in Fig. 9. This tire broke in nine pieces and four of the fractures had well-defined fatigue

cracks. There is no question but that failures were caused by the rough finish. One of these failures is shown in Fig. 10, the fatigue crack starting from the counterbore. Here, again, the sunburst effect, radiating from the crack, is clearly evident. An enlarged view of this particular fatigue crack is shown in Fig. 11. A close examination of the dark area indicated that it was plainly a fatigue crack, starting from the tool marks.

Another example of rough boring is shown in Fig. 12. This surface was somewhat corroded, so that the tool marks do not show as clearly as they otherwise would. This particular tire broke in two places. One of the fractures started from a fatigue crack, which is shown in Fig. 13. This is only a small crack and may appear insignificant, yet it did result in the fracturing of the tire.

"Why did we not have more tire failures in the past, when the tire boring was done even more roughly?" This is a question that I have been asked. In the first place, it is questionable if the machining was rougher than some of that illustrated in this article. If, however, we grant that the tires are not so roughly finished today as in the good old days of the past, we must remember that the service to which they are subjected is much heavier today. With this more severe duty it is quite essential that every precaution be taken to insure smooth boring.

The use of tungsten carbide tools has proved that tires can be bored quickly and cheaply and that an almost glass-like surface can be obtained. It does not require long to finish the bore of a tire at a cutting speed of 150 ft. to 250 ft. a minute, and tools costing a few dollars each will bore several hundred tires. At this rate a single tire can be bored in from 20 to 30 min. We must not forget, also, that it is extremely important that all sharp edges be properly and smoothly rounded off.

In this particular article I have referred only to locomotive tires. As a matter of fact, however, a passenger car tire seldom fails from fatigue cracks in the bore. In the first place, the machine finish is ordinarily far better than any illustrated in this article. Passenger car tires do fail, but generally from other causes. A consideration of the causes of passenger car tire failures will appear in a later article.

So You'd

Rather Be a Puritan?

(This article requires some explanation. The publication of the Roundhouse Foreman's Daily Log in the *Railway Mechanical Engineer* of May, 1935, page 207, started a lively discussion in our columns. Not all of the contributors agreed with the writer of the "Log." He, on the other hand, has remained quietly in the background, but apparently doing a lot of thinking. He is a bit of a philosopher. Here are his conclusions—Editor.)

Imagination is, we are told, one of the few characteristics which distinguishes man from other animals. From the imagination of Doctor Rudolph Diesel came the principle of the prime mover which other imaginations have harnessed to the railroad's new and successful bid for passenger transportation supremacy. It was, no doubt, Doctor Diesel's imagination, turned morbid, that caused him to disappear from a ship crossing the English Channel less than a year before engineers the world over began to accept his valuable theories and practices. Let us, then, be not bashful about exercising our own fancy.

Sounds Like a Big Promotion

Suppose that we are summoned to the office of a manufacturing executive, told that we have been recommended to him for a place in his organization, and we hear the position outlined as follows: "The sole responsibility for the successful operation of from 25 to 40 mechanical units will rest on you. These units cost about $85,000 each when new, and their average is 16 years. Our figures show that they have been repaired, periodically, but the years of use have removed something from these machines which is not, economically, replaceable. This fact, however, will not be accepted as a reason for poor performance. The plant in which you will maintain these units represents an investment of a quarter of a million or so dollars. You will have a staff of about 40 men, and an operator and an assistant will be allowed whenever an additional unit is put into production."

This, to us, begins to sound like a real job; we have seen and heard of plant managers; maybe those diligent years are going to be rewarded. Some of those things we have so long wanted may come our way. The kids can go to college when they grow up. The wife can go ahead with her delayed social and church work. We can join a service club or the country club.

But, There Are Limitations

The executive continues: "Your judgment as to forces and materials will be curtailed; your suggestions and requests will be supervised by this office. You will be required to maintain the units so that any, or all of them, can be put to work on short notice from the production department; and once started, they must continue to produce until the work is completed. Failure of a unit while in production may mean loss to us and will surely reflect discreditably on you. Considered on an hourly basis you will be paid about the same as the mechanics under your direction, but we will allow you to work twice as many hours, twelve or more every day, each day of the week. Even at that your pay will be less than that of the machine operators.

"We are not offering a chance to work into a partnership as a substitute for low salary. There are no partnerships. The only possibilities, so far as advancement is concerned, are more responsibility, with a small increase in salary. We have men working in similar positions who, after 20 years, are earning as much as 20 cents an hour more than their mechanics. You have about one chance in one hundred of becoming one of the district supervisors and your chances of occupying this office are, to say the least, remote. Advancement depends on your learning how to avoid difficulties, or their consequences. There are any number of natural occurrences for which you may be removed from your position—without notice."

The Answer Is "No!"

Now let us imagine what our reaction to such a proposition would be. Those dreams which started themselves during the first part of the explanation died a sudden death and we might doubt the man's sincerity in expecting to find one having the qualifications obviously demanded by the position, who would be willing to waste his talents on such an endeavor. We might suspect that the job required a stronger, more enduring back, rather than the discerning mind we had thought they desired the use of—that this executive wanted a Samson, rather than a good mechanic with well developed supervisory ability. We might even be mildly insulted by deducting, from the hours of service demanded and the salary offered, that our time was the only valuable element the organization could find in us, that the only qualification considered in selecting us from among our fellows was our supposed willingness to sell to them another third of our lifetime.

The answer to that proposal is not hard to imagine. Coming from an organization outside the one in which we were trained, the answer would be definitely, "No."

But—In Railroad Service

Perhaps, though, coming from our own company it would sound something like this: We are summoned to the office of the master mechanic and are given the following invitation: "We need a roundhouse foreman, do you think you can handle the job?"

The answer to that is, just as definitely—"Yes."

And why not? We are going to be boss. Our ability is challenged, our vanity is touched, our loyalty and devotion have been recognized. It is promotion! This is our big moment, and let us savor it well, it may be the last moment of elation that will come of our "success." This instant of heady happiness has got to compensate for hours of wearisome worry, has got to be stretched to carry us through those times when some failure or other causes us to wonder if we are the man we thought we were when we said "yes" to the master mechanic.

What Will the Doctor Say?

On our way home to ask the wife to exult with us, provided of course that we have been able to contain ourselves and not phone her the good news, let's do something a bit unconventional, let's stop at the doctor's office to get answers to a few questions that a sensible man might ask. The doctor examines us and reports that we are in reasonably good health, so we'll ask him for suggestions as to how to maintain that health. Do you believe that he will recommend working twelve hours a day, seven days week? Not on your tintype, or on mine. Will he say that eating at least one meal every day while under a mental strain will cause our digestive organs to prosper, that a delayed dinner once or twice a week will ward off ulcers?

If we tell him that we are going to spend ten of the twelve hours on our feet will he call it moderate exercise or over-indulgence? No! He will probably tell us that our project is one of the world's best ways to court premature old age, and should he be an experienced life insurance examiner he will unquestionably suggest that such an occupation will reduce our life expectancy by ten or more years. Should he be a nerve specialist, he'll make the ominous prediction that very few years will pass before we are pleading with him for a cure for nerve disorders which severe physical and mental effort, combined, bring on, and which his science has not yet conquered. If he is the family physician, he might suggest that we start payment now for the treatment that we will certainly be in need of at some later time.

How About the Psychologist?

From this interview let us go to a psychologist to find out if we are heading for a normally happy mental life. Here we'll be told that several of man's psychological needs will be fulfilled by this work. Ascendancy over a group of fellow men will satisfy our ego, the mental stimulus toward action will certainly not be curbed, the natural will for material accumulations will be gratified in a way, and mental growth will for a time be stimulated. Aside from those conditions, we will learn that our mental life is lopsided as our other existence. If C. C. Furnas were consulted he might quote from a chapter of his latest book "The Next Hundred Years".

"Remember that for the average man work is drudgery, there are many thousands of more interesting things to do than earn one's daily bread. One passes this way but once and there should be opportunity to do a few of the things that one enjoys, the first requisite of opportunity is time—that means leisure—relief from the daily grind (note that I say leisure—not idleness). If there is anything in being alive—certainly a considerable portion of each year should be available for indulgence in the activity most desired—bridge, fishing, gardening, swimming, climbing, sailing, puttering, collecting any of the absurd things that are collected, reading, writing, plumbing, tinkering, singing, social uplifting—anything except work. . . . No budget would be complete without an allowance for recreation. In all worlds except the Puritan it is an item of great importance, hardly ranking with food but still well up in the list. . . . Leisure is much more important than an extra car—an extra ton of food—extra suits of clothing—radios, canoes or what not."

Let us reflect for a time upon these statements and their relation to our projected position. First we realize that in the sense Mr. Furnas uses the word, we want to be "average". The opposite, in this instance is maniacal, and we are not yet ready to join the ranks of the mentally unbalanced. By resorting to the most elementary of mathematics we can establish our opportunity for leisure, or lack of it. We are going to be on the job twelve hours, we are going to use at least one hour getting to work and back, and there is that inexorable demand for sleep to be reckoned with. It has been lately proven that the sleepless marvels of the past invariably nodded and napped enough during the day to bring their total unconscious hours up to the normal eight. We've got to spend part of the remaining three hours on routine care of this body from which we expect so much, so possibly two hours of the day belong to us, and it is a safe bet that nothing more rigorous than plain and blessed idleness is going to claim these hours most days.

How About the Time Budget?

This is our time budget, and if we do take time out to indulge in a bit of enjoyment, some item on that budget must suffer. We belong to the working classes and have always known that life is, mostly a serious proposition, but are we prepared to accept such unremitting seriousness? We have always realized that "Life is not all beer and skittles", but if we must forego the beer, wouldn't an occasional game of skittles be refreshing?

It is to be remembered that we are undertaking a daily program, so where is that "considerable portion" of our time for recreation? We are going to have two week's vacation—maybe—and another good bet is that those two weeks are going to restore neither our equanimity nor our vigor, that we will return to work with very little more sparkle in our eye or spring in our step than there was when we left. Of course these things are by no means essential, they are just among the nicer things in life that others have and we would like to have.

The result of our problem in addition and subtraction shows that we are going to trade about nine-hun-

dred and ninety nine of every thousand things that other men like to do, for the job. This a polemic statement, but a careful perusal of the letters and comment from engine house foremen, published in the *Railway Mechanical Engineer* during the past year will substantiate the premise that in the great majority of cases it is the closest approximation of existing conditions.

It seems that we are going to be, with the exception of our work, in the curious position of living in a modern world, in a developed, highly civilized nation, yet not be able to partake of the finer attainments of that civilization, for the spreading of which the organization to which we belong has been largely responsible. Our company may transport actors and actresses, or their filmed activities to the theaters of our town, speakers to our auditoriums, and books to our libraries, but not for us. We may know now that Robert Burns and Van Dyck are the names of men who did something besides get their pictures on cigar boxes, but we'll soon forget it.

A Call on the Pastor

Now, if we should see the pastor of our church, as we go home, let us quietly cross the street, for from now on we are going to get our religion vicariously. To those who would argue that man has a spiritual side which needs attention, we must turn a deaf ear. We can console ourselves with the often used equivocation that we can be a practical rather than a practicing Christian.

We cannot be certain just what dictated the reduction of hours for all classes of labor from twelve hours to ten, then to eight; strikes, admittedly were a factor. Whatever the cause, it is undeniable that, considering the national welfare as major among accomplishments, the change turned out to be sound economics. Labor leaders are now urging the six-hour day; when this is achieved, are we going to be working two full shifts? Successful men in all lines quite frequently tell interviewers that their success is due to having always delivered a little more than was expected, usually by studying or working a little after the required hours. We are, according to that hypothesis, automatically excluded from further advance, for in accepting the job we have offered all our available hours, have contracted to deliver the last ounce of expendable effort.

We may consider that the offered regime is calculated to train us for a bigger, better position and we may oppose that with the conclusion that the training period will be not only exhaustive—but exhausting; that we will know the condition that every athletic coach has learned to avoid, that of being trained too fine.

What to Tell the Wife?

After these consultations and reflections, what are we going to tell the wife? Simply that we have been promoted. After all, we may be that one out of a hundred who goes on to a minor executive's place; may be that odd one who is going to be chief mechanical officer, and even if we aren't, we are young, the job is *now* and the breakdown is in the nebulous future. Besides—we can use the extra money, and we wouldn't like to have it noised about the plant that we were afraid of the job, or have the lunch time sessions condemn us for not "being able to take it".

From the Managerial Viewpoint

Now, while the throttle on our imagination is still wide open, let us ride for a few miles on the other side of the track. Assume that we are the executive about to hire a manager for our plant. Are we going to feel safe in turning it over to a man who, by accepting that sum as annual salary, admits that he is worth less than one-tenth of one per cent of the investment in the plant? There is very little of the routine about the job and are we being consistent in demanding twelve hours of efficient supervision from the man on it?

Are we going to admit that all phases of railroading have changed by spending millions of our company's dollars on new equipment, then deny that change by insisting that the new machinery be maintained in the manner of 1880? Are we going to accept and profit by the advances of scientists in the exact fields, then jeopardize those profits by refusing to accept the findings of practical industrial psychologists with regard to that most important item, the human machines we use? There are available charts of human efficiency just as comprehensive as any of these thermal efficiency diagrams for engines we have studied. Are we going to learn of the amazing drop in the human efficiency curve after six hours service, then be blindly inconsistent in demanding one hundred per cent production from a plant in which the efficiency of the leaders is less than fifty per cent for half of each day?

There has always been a supply of potential foremen. There have always been more machinists that wanted to be foremen than there were jobs for them. We worked twelve, fourteen hours a day when we were foremen, didn't we?

Is past existence of any condition ample justification for its continuance? How many shippers are going to continue to patronize a road that refuses to speed up its schedules just because the present ones have been followed for many years past? We do need something more in our foremen than willingness to spend their time—a great deal more; can we assume that the supply will be perpetual? We might observe the relentless trickle of our younger, better mechanics into other lines and see that in the coming regrowth of industry our staffs are going to be raided, unless we make the positions more attractive. We are, right now, experimenting more than at any time for many years; we have tried many solutions for our equipment maintenance problems, might it not be good business to try a reduction in foremen's hours as an experiment in human engineering?

Let us, as a final consideration, realize that the majority of foremen will never be more than that; that the odds quoted by our prospective foreman hold true, that there is only one master mechanic in a hundred and that there are only four or five embryo mechanical department officers in all the plants of our company. With regard to these four or five, is it not plausible that one of the reasons why so few mechanical department executives ever advance beyond their department is that they are so busy tending to their own job that they haven't time to learn the other phases of railroading?

There are those who will impugn the imagination which conceived this colloquy as being fully as morbid as Dr. Diesel's in his last days. Let them, too, reflect. Do they not number among their acquaintances several ex-foremen who have been returned to the ranks, either by the management or by their own request; do they not know men who have been demoted because of loss of physical or mental activities; can they not point to numbers of has-beens, or has it not been their experience to observe more foremen die in harness than in the comfortable retirement, to which their years of effort should have entitled them? Let those men who have not observed such things spend the time they would use in attacking these ideas, in congratulating themselves, for they are rare indeed.

It is not our intention to insist that railroad foremen cannot appreciate that it is a grand world, full of good things, that they are barred from all enjoyment of life—it is only that their appreciation and enjoyment must be largely primitive.

SIGNS OF SAFETY

"WHY, it's—it's deplorable! Absolutely deplorable!" Master Mechanic Carter of the Plains Division of the S. P. & W. pounded the table and glared at the three foremen seated across the table from him as though daring them to dispute the fact. "Nine personal injuries in five months, three of them reportable! It's deplorable, I tell you! Nearly twice as many as we had in the mechanical department at Plainville all last year, and every one of them preventable. How am I going to explain it? I'm asking you! How do you expect me to explain such a record?"

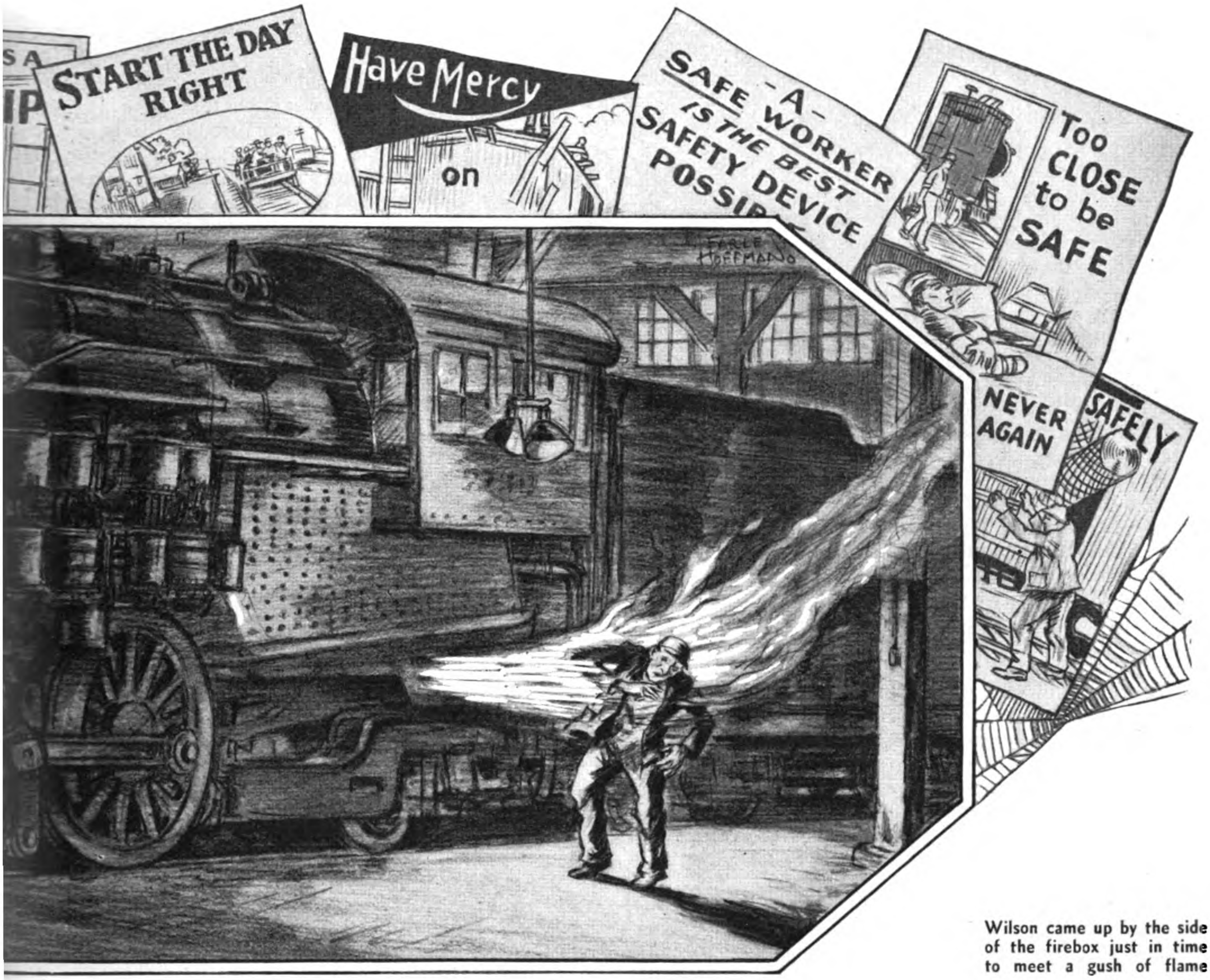
John L. Starkey, the general foreman, squirmed and cleared his throat. Jim Evans, the roundhouse foreman, bit off a hunk of horseshoe and edged his chair over towards the cuspidor. Bob Parker, the night foreman, was first to speak.

"Well, only one of the reportable injuries happened at night."

"Yeah? A hostler helper fell off the top of a locomotive when he was fixing to put sand in the dome of the engine. Broke three ribs and got all skinned up. It's a wonder he wasn't killed. That was on your shift."

"The light over the sand crane wasn't burning and he couldn't see. We need more lights around the place. When I was on the Big Four—"

"Never mind the Big Four, Mr. Parker. What do



Wilson came up by the side of the firebox just in time to meet a gush of flame

by Walt Wyre

you say, Mr. Starkey? You're the general foreman. After all, it's up to you to explain why we are having so many personal injuries in the roundhouse here at Plainville,—and how to stop them," the master mechanic added.

"Well, I don't know. I've tried to make things as safe as possible. We've had guard rails put around all gears and pulleys. I've had the painter make up some large safety first signs."

"Seems like I heard something about one of them signs. The one on the pole by the arch brick house; somebody bumped into one corner of it with an eye. Came very near being another reportable injury," the master mechanic said sarcastically.

"Yes, they put it up just a little too low. I've had it raised high enough so there's no more danger of that," Starkey explained.

"Well, I'm giving you fair warning. Accidents must be reduced. I want you to hold a formal investigation of every man that gets hurt on the job. Find out why and how the accident could have been prevented. That's all."

Next morning Starkey called a meeting of all employees. He told them in part what the master mechanic had said. After the meeting he gave orders to the painter to make up a lot of signs bearing safety slogans to be posted around the shops. He called the safety committee in the office and talked to them. He told them to watch out for unsafe conditions and report them to him.

The safety committee took the general foreman at his word. Welding screens were overhauled and new ones made. Guard rails were placed on the turntable and around the drop-pit. Holes in the floor were repaired. Jacks were turned in to be overhauled. Members of the committee seemed to vie with each other each trying to find the most things that might possibly cause an accident.

THEY went two weeks without an accident. Starkey was beginning to congratulate himself that every safeguard had been provided and accidents a thing of the past. Then Wilson, a coppersmith helper, got hurt. The fire builder was putting a fire in the 5092, an oil burner, as are all of the engines on the Plains Division. Wilson came up alongside just in time to meet a gush of flame from the fire-box. His face was badly burned, blistered solid on one side. He lost two weeks and they thought for awhile his right eye would be damaged.

The fire builder claimed he yelled "look out below for a fire on the 5092." The oil didn't ignite right at

once and he opened the firing valve a couple more notches. Then it flashed. Wilson claimed he didn't hear the fire builder yell. Anyway, it was another reportable injury.

Carter raved. Starkey had more signs painted and bulletins posted until the roundhouse looked like a highway intersection two miles out of town. The safety committee renewed their activity with a will. One of them proudly suggested that fire builders be provided with a whistle, like traffic cops use, to signal when he was going to light a fire in an engine.

Starkey bought the whistles himself,—three of them,—and gave one to the fire builder on each shift. The fire builders blew lustily when lighting a fire, and lots of times when they weren't. Some of the men learned to imitate the whistles and the place sounded like Times Square in New York at five p. m.

In the meantime Evans was having troubles enough of his own while the general foreman was making his safety first campaign. Business was going good, but the engines were not. He was about four engines short for the number of trains they were running and locomotives had to be dispatched in many instances without proper repairs. March winds were whipping sand and dust across the prairies. Hot pins and boxes were daily occurrences. Rain and snow had fallen, even in unusual quantities in some sections of the country, but not along the Plains Division. The country was dry as a popcorn ball and the sand as light. Piston packing cut out quickly in spite of increased lubrication.

Altogether more repairs were needed. The stores department, buying on the basis of previous consumption, was short on repair parts. Material was being constantly ordered to be shipped by passenger, heavy material like pistons, piston rods, valve castings, and bull rings. At that there were numerous occasions when engines had to be held waiting parts.

While Evans was busy trying to divide twenty trains into eighteen engines and make them come out even, Starkey was busy with his safety campaign. He was getting results, too. That is, far as the records showed. There had been no more reportable injuries since Wilson got burned. There had, however, been a flock of minor injuries—mashed fingers, twisted ankles, and such. Of course Jordan getting his arm hurt would have been a reportable injury if he had not come back before three days were up. Starkey put him to sorting and indexing blue prints until his arm got so that he could use it. He was running a lathe at the time it happened. He was chucking a brass to make a knuckle pin bushing and left the wrench sticking in the chuck when Reed, another machinist, stopped to talk to him. While they were talking Reed absent-mindedly pushed the starting button of the motor-driven lathe. The wrench struck Jordan on the wrist, almost breaking it. He stayed off two and a half days and spent the rest of the week sorting blue prints.

THE next reportable injury that showed on the record happened one Sunday. Evans was running the place alone and short-handed on account of reduced force. He had just gotten his lineup and called the dispatcher to let him know what engines were to be used when the dispatcher called him back.

"There's going to be two sections of No. 10 tonight," the dispatcher said.

Evans swore and hung up the receiver. As it was, he just had enough engines to go around and the extra section made him one short. He took a fresh chew of horseshoe and sat down to figure it out.

"Well, let's see. The 5074 is doped to get in about ten o'clock on 81. I can get her for first 10. The 5086 will be on the first section, she's a good engine. We can run her through on the second section without changing the lineup. Yeah, that'll get it," he told John Harris, the clerk. "Guess I'll take a turn through the house to see how things are going," he added.

The phone rang insistently just as Evans started to open the door. He paused to see who it was and what they wanted. It was the dispatcher and he wanted to speak to the foreman.

"Yes, Evans talking . . . What!" The foreman gripped the telephone receiver so tight that his knuckles were white. He reeled as though stung on the forehead by a hornet. "All right," he said weakly, and hung up.

"What is it, Mr. Evans? Something wrong?" the clerk asked.

"Not much; just the 5074 tore herself up—driver tire broke—the train is tied up on the main line at Wister. Give the caller an engine crew. I'll see how the 5090 is getting along." Evans left the office like he had hot coals in his hip pocket.

The 5090 had a fire in her. The needle had just left the peg. The foreman told the fire builder to hook up another blower on her and get the engine hot quickly as possible. Then he thought of the two sections of No. 10. There was only one thing to do—get another engine for the passenger train. The 5078 was due to come off the drop-pit the next day. Evans looked her over and decided that by calling in a couple of machinists and helpers he could get her ready. Boiler work was O. K. He went back to the office and told Harris to call the four men.

"We're already over on our allowance for this month," the clerk reminded him.

"Can't help it; we've got to get an engine for No. 10," Evans replied and bit off a hunk of horseshoe that would have choked a billy-goat.

The machinists went to work with a will on the 5078. Rods were ready to go up when they started. They had finished putting up the rods on the left side and were getting ready to start on the right. They had all of them lined up alongside the engine. Then it happened. Another reportable injury! A side rod turned over and caught a machinist's helper's foot right across the instep. Evans had the man taken to a doctor at once. Two broken bones in the foot. He'd be off at least three weeks, the physician said.

Looks like that was enough for one day, but trouble hadn't finished with the place, not by a long shot.

The 5084 was finished about four-fifteen. Jenkins, a machinist, ran the valves over.

"How is she?" Evans asked.

"Well, looks like she's pretty badly out," the machinist replied.

The swearing Evans did then would have been an inspiration to a top sergeant in the army. He swore by ear, by note, and with variations. After he was out of breath he took the tram and ran the valves just to be certain. The machinist was right. The valve rod would have to be shortened 5/16 of an inch. The blacksmith wasn't working. By the time he could be called and get the job done it would probably mean a serious delay. And wouldn't that be nice! An engine failure, a reportable injury, and a delay on the Limited all in one day. Carter would have six conniptions and probably a stroke of apoplexy when he heard about it.

Evans took a walk to collect his thoughts. The machinist and helpers took advantage of the foreman's absence to climb up in the cab for a smoke. Jim strode down through the house leaving a stream of tobacco

juice in his wake. He reached stall number nine, then turned and headed back so suddenly that he made three steps before his shadow caught up with him. The machinists and helpers saw him coming and slid out of the cab.

"Here, Jenkins," he said to the machinist. "Make a bushing for the valve rod."

"That's a new one in it," the machinist said.

"Here; I'll show you what I want;" Evans went on, "make a bushing for this valve rod and make it eccentric. You can either turn the outside first or the inside, don't make any difference, but the hole wants to be thrown 5/32 of an inch off center. When you press it in, have the thin side of the bushing toward the rod. That will shorten the travel 5/16—"

"I see it," Jenkins replied and headed for the machine shop.

When the bushing was finished, the engine trammed perfectly. A dowel was put in so that the bushing couldn't turn and the engine was ready to go. Evans instructed the rod cup man to use plenty of grease on all bushings. After the hostler had run the engine up and down the lead long enough to limber the bearings up a little, the foreman looked over all the bearings. Any that showed signs of running hot were doused with valve oil. Evans gave the engineer an extra pint of valve oil and his best wishes and called it a day.

NEXT morning when Starkey learned what had happened the day before he turned pale around the gills. All morning he was jittery as a June bride waiting at the church for a delinquent groom. Every time the telephone rang, the general foreman jumped.

Evans, too, was worried, but no use getting excited, he figured. That wouldn't help matters any. Anyway, he was too busy to put in much time crying over spilt milk. Bemoaning accidents and engine failures that had already happened wouldn't wipe them off the records nor prevent the occurrence of others. The thing to do, he reasoned, was to figure out why they had happened and prevent a recurrence. As he made the rounds, Evans subconsciously pondered over the reason for the many personal injuries in the Plainville roundhouse.

About two-thirty in the afternoon the general foreman was sitting at his desk eating aspirins and figuring out some new signs and bulletins to be posted around the shop. When the telephone rang he came out of his chair like a jack in the box.

John Harris, the clerk, answered the phone. It was the call Starkey had been looking for all day. The master mechanic wanted the foremen in his office at three o'clock.

"Now, the first thing I want to talk about is engine failures," Carter began. "We had another one yesterday, a disgraceful failure on one of our best trains, a broken driver tire on the 5074. Starkey, what do you have to say about it?"

"Er-ah-I don't see how it could have been prevented," the general foreman began uneasily. "I have examined the broken pieces and can't find any indication of an old crack. I wasn't working yesterday," he added.

"I was!" Evans spoke up, a little angry at the obvious attempt of the general foreman to pass the buck.

"Well, perhaps you can explain why the tire broke on the 5074," Carter glared.

Evans rolled his cud of horseshoe around to a more comfortable position. "Yes, I think I can explain. The tires on the 5074 are too thin."

"They are not down to the limit, are they?" the master mechanic asked.

"No," Evans replied, "but they nearly are. They are too thin for heavy passenger service. We just took a chance and lost."

"I'll look into that later," the master mechanic said. "The main reason I called you men in was account of personal injuries. Another reportable injury yesterday. They've got to be stopped. What about it?"

Starkey squirmed uneasily in his chair. As general foreman it was his duty to answer the master mechanic's questions, and he didn't know just exactly what to say. "Well, I am having some more bulletins posted and signs put up," he said.

"I don't care just how you go about it. What I'm interested in is reducing the number of personal injuries. If we can't reduce the number some one is likely to take our jobs that can," Carter said significantly. "What's your idea on improving our personal injury record, Evans?"

"Seems like we are going at it from the wrong angle," the foreman replied, glancing at Starkey.

"Evidently there's something wrong," Carter said sarcastically. "Maybe you can tell us what it is and how to correct it."

Evans flushed at the thrust. "Yes, I think I can tell you what's wrong. Instead of teaching every man to work, think, and act safety, we are really teaching them to be careless."

"Why, I've had bulletins posted and signs put up urging safety on the part of every employee," Starkey cut in.

"Yes, that's true," Evans replied, "but seems to me that we have overlooked the idea of making every man feel that it's his personal problem to reduce injuries. We have put guard rails around this and that and shields over everything we could think of until the men unconsciously feel that it is no longer up to the individual. It's the same way with signs and bulletins. They no longer pay any attention to them."

"Do you mean gears should not have shields over them and belts should not be guarded?" Carter asked.

"No, not exactly," Evans replied, "but such things can be carried too far. When they are, the men get a feeling of security that breeds carelessness. Take the guard rails around the turntable. Outside of being a blamed nuisance, they haven't stopped injuries. Here's what I'm getting at. A safe worker is the best safety device possible."

"I've got that on one of my signs," Starkey interrupted.

"Yes," Evans replied evenly, "that's true."

"Well, what would you suggest to remedy the situation?" the master mechanic cut in.

"Well, my idea is to educate the men; impress on them the fact that it's not entirely our job to see that they don't get hurt. A careless worker can find some way of getting hurt in spite of safety devices."

"That's just what I've been trying to do," the general foreman interrupted.

"Yes, that's true," Evans said. "We've been carrying on a safety campaign without letting the men in on it, that is, with the exception of a few of them. The men on the safety committee don't get hurt. That's because they feel it's part of their job."

"Don't you think bulletins and signs do any good?" Carter asked.

"Yes, sir," Evans replied, "long as they have something to say that will interest the men. But I do think that after a sign or bulletin has been up so long that it is sort of a permanent fixture every one ignores it. Just like the posts in the roundhouse. Everyone knows posts are there, but no one pays any attention to them.

I'd suggest tearing down all old bulletins and signs, bulletins especially. Then keep the bulletin board up to date and change the signs occasionally.

"Is that all you have to suggest?" the master mechanic asked.

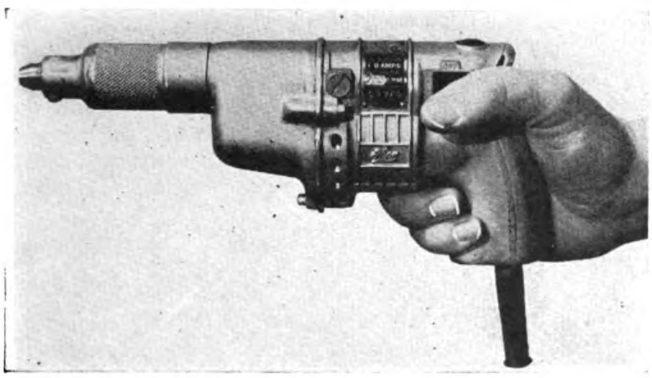
"No; I'd suggest that in order to make every man feel that it's part of his job we have a three-minute meeting every morning at eight o'clock for a time, at least. Call on different employees for talks on safety. Chances are the speeches wouldn't amount to much, but the men would go to work thinking about safety, and that's what counts. As soon as they realize that dangers exist and it's their job to avoid them, I believe our record will improve." Evans bit off a hunk of horseshoe as he waited for the master mechanic's reply.

"O. K.," the master mechanic said. "We'll try your plan thirty days and see what happens."

Two months later Carter proudly displayed the banner awarded the roundhouse at Plainville for going thirty days without a single personal injury.

A One-Hand Portable Electric Screw Driver

A small, light-weight, portable electric screw driver, capable of driving all sizes of screws from No. 4 to No. 12 by simply changing the finder and bit, is being introduced by the Independent Pneumatic Tool Co., 600 W. Jackson Boulevard, Chicago. This new Thor U16 electric screw driver follows the design of the U14 electric drill recently placed on the market, and incorporates several new features in an electric screw driver. All weight is concentrated at the operator's hand, eliminating overhanging weight and providing easy, untiring operation with "finger-point" accuracy, making it a real



Thor portable electric screw driver

one-hand tool. The smallness of the screw driver, only 10½ in. overall, permits use in places ordinarily inaccessible. A powerful motor, dependable tension adjustment, hand-wound armature and special commutator construction, provide efficient operation.

Ball bearings and heat-treated helical gears reduce noise and vibration to a minimum and increase motor efficiency. These features also reduce the heat generated. The Thor ventilating system provides effective cooling of the motor which increases the power by enabling the motor to pull, without overheating, a sustained load close to its maximum capacity.

This tool has a free speed 700 r.p.m. and weighs complete with screw driving attachment 3½ lb. It is equipped with No. 250 slip-clutch attachment.

Pedestal Grinders For Carbide Tools

Two new pedestal grinders—a 6-in. and a 10-in. grinder—designed for the grinding of cemented carbide tools, are announced by Carboloy Company, Inc., Detroit, Mich. They have been developed to meet the requirements necessary to grind carbide tools more rapidly and without injury to the carbide tip and are said to be suitable not only for resharpening tools dulled in ordinary use but also for the rapid reconditioning of carbide tools on which the tip has been accidently broken, the reshaping of carbide tools, and the rapid grinding of milled and brazed carbide tools (milled and brazed tools are carbide tools finished except for the grinding operation).

The 6-in. grinder is designed for the interchangeable use of silicon-carbide cup wheels for roughing and fin-

The 10-in. Carboloy pedestal grinder

ishing, diamond wheels, and lapping discs. It is intended for plants having carbide tools in the smaller size range—up to about 5/8 in. square—and a relatively few larger sizes of tools. The 6-in. grinder also supplements the larger 10-in. grinder for plants whose tools require reconditioning on diamond wheels or lapping discs. For such work all sizes of tools can be accommodated.

The 10-in. grinder is designed for both peripheral grinding on straight wheels (silicon carbide) and face grinding on silicon-carbide cup wheels. Both roughing and finishing can be done on the one machine.

A few of the more outstanding features claimed for these machines are: (1) Provision for rapid wheel changes when necessary; (2) Vee-belts made accessible for quick changes or adjustments by simply removing one wheel guard and side louvre; (3) Exhaust outlets provided for rapid connection to blower systems; (4) Both grinders provided with tool rest tables sufficiently large to accommodate all sizes of tools, and in each case

the tables extent well beyond the face of the cup wheels and around the periphery; (5) Both the 6-in. and 10-in. grinders have reversible motors which facilitate grinding of either left or right hand tools; (6) Motors are mounted inside pedestals of both grinders and are insulated to eliminate vibration, and are dust protected; (7) The 6-in. grinder is provided with reservoir and needle valve for lubrication of diamond wheels.

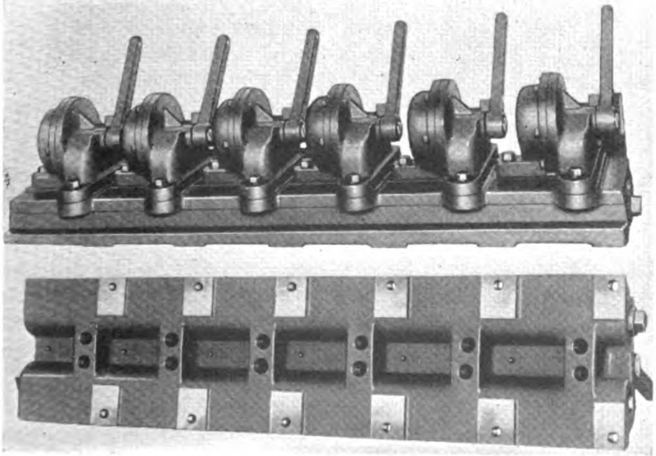
Manifold Air-Control Valve

A valve for the control of compressed air or hydraulic equipment, developed by the Hannifin Manufacturing Company, Chicago, comprises a type of "Packless" manifold valve of unusually compact construction and arranged for a simple piping installation. This valve is for the control of six double-acting air cylinders from a single point on a Jordan spreader. Other types are available for the control of any number of cylinders on air or hydraulic equipment used in railroad shops. The base of the valve is one piece, with inlet and exhaust ports at the ends and cylinder ports in the bottom. Piping can be arranged in the simplest manner with minimum number of connections. Inlet and exhaust connections can be made at either end of the base. Manifolds can be furnished with any number of valves required.

Hannifin "Packless" air control valves are of simple, efficient design, with a minimum number of parts and no packing whatever. The bronze disk which controls the air flow is ground and lapped to make a perfect seal with the seat which is similarly finished. This effective design prevents leakage and maintenance troubles. The disk and valve seat are restored to original efficiency by simple re-lapping at infrequent intervals.

Manifold valves are available in three-way and four-way types. Type MK has 45-deg. movement and no shut-off position, air being admitted at all times to one side or the other of the air cylinder. The Type MV has 90-deg. movement with outlets open to the exhaust when the lever is in the shut-off position. The Type MP has 90-deg. movement with the outlet and exhaust ports closed when the lever is in the shut-off position.

Besides its use for the control of compressed air and hydraulic equipment, the manifold valve is said to be well adapted to the control of fluid and gas handling and pumping operations, filling and emptying storage tanks, and many similar uses.



Hannifin manifold-type Packless four-way air control valves for the unit-position control of multiple air or hydraulic cylinders

High Speed Turret Lathe

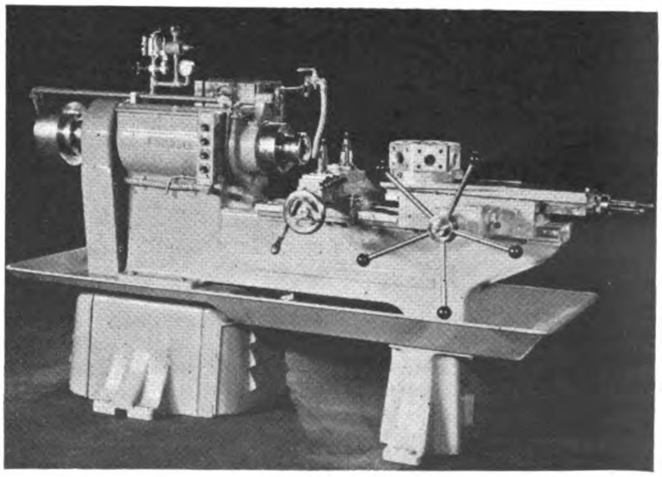
A simplified high-speed turret lathe for a wide range of both ferrous and non-ferrous material machining jobs has been designed by the Gisholt Machine Company, Madison, Wis. This machine is intended for both quantity production and small lots, is of the same general design as the Gisholt No. 3, No. 4 and No. 5 universal turret lathes and embodies many of the same labor saving devices. The automatic collet chucking capacity for round, hexagon and square stock is 1½ in., 1⅜ in. and 1⅛ in. respectively, and uses either an 8-, 10-, or 12-in. scroll chuck. The machine has a maximum of 18½ in. swing over the steel-topped ways.

A feature of this machine is its drive. Primarily designed for high-speed work, all gears and clutches have been omitted from the spindle and headstock. The spindle, mounted on tapered roller bearings, is driven by vee belts directly from the motor mounted in the cabinet under the headstock. These belts drive an aluminum sheave which is mounted on the spindle back of the rear bearing. This sheave is so mounted that it can be quickly removed and replaced by another of different diameter, varying the speed in much the same manner as would be done by pickoff gears. A corresponding change is made in the motor pulley with an adjustment of the motor mounting to compensate for belt length. A variable diameter motor sheave can also be supplied. By these means exactly the correct speed for any desired diameter can be secured so as to utilize cutting tools to the best advantage and to minimize the inflexibility of the variations for which two- or four-speed motors are wound.

Control of the spindle is by means of a push-button panel on the headstock, providing start, stop, reverse, and the various speeds of the motor.

The hexagon turret and its stop roll are automatically indexed to the next position with a back movement of the slide. As the slide advances to the work, the hexagon turret is automatically located and clamped in place. The operator need not take his hand from the pilot wheel to accomplish this whole operation. The machine is offered with either power-feed turret or hand-feed turret, the latter being the more usual. The saddle may be clamped to the bed at any position suitable to the work.

Three types of hand-operated cross slides are offered and any one may be furnished with or without hand longitudinal adjustment to suit requirements. The three cross slides are lever operated, screw operated or a combination of lever and screw.



Gisholt 18-in. high-speed turret lathe

The "Silver Jubilee" of **the London & North Eastern leaving Newcastle station** at the same time as **the 10 a.m.** Manchester and **Liverpool express**

Globe photo

NEWS

Eastern Car Foreman's Association Outing July 23

THE Eastern Car Foreman's Association will hold its annual golf tournament and field outing on Thursday, July 23, at the Race Brook Country Club, New Haven, Conn.

W. H. Winterrowd Honored

THE honorary degree of Doctor of Engineering was conferred upon William H. Winterrowd, vice-president of the Franklin Railway Supply Company, by Purdue University at its recent commencement. Mr. Winterrowd was graduated from that institution in 1903 with the degree of bachelor of science in mechanical engineering. The citation for his honorary degree read: "Engineer of high repute, executive of recognized achievements, humanist of inspiring example."

Dedication Ceremonies for "City of Denver"

DEDICATORY ceremonies for the streamliner "City of Denver," placed in service by the Union Pacific on June 18, were held in Chicago and Denver. The ceremonies in Chicago took place in the Chicago & North Western station between 4:30 p.m. and 5:00 p.m., eastern time, while those in Denver were held simultaneously at the Union station in that city. The ceremonies at both cities were broadcast over the National Broadcasting Co. network.

New York Law Requires "Helper" on Diesel Engines

GOVERNOR Lehman of New York has signed the bill passed at the recent legislative session, which amends the New York State railroad law, so as to require a two man crew on "fuel-electric" (Diesel) engines.

N. Y. C. "Mercury" Christened

THE New York Central's new streamline train, the "Mercury," was christened at Union station, Indianapolis, Ind., on June 25 by Miss Louise Landman, daughter of L. W. Landman, general passenger traffic manager of the road. She broke over the nose of the Mercury's locomotive a bottle of champagne from Sandusky, Ohio, which is along the route the train will cover on its proposed regular run between Cleveland, Ohio, and Detroit, Mich., via Toledo, Ohio. The Mercury is expected to go into regular service on a daily round trip on July 15.

Pennsylvania Wins Modernization Contest Award

THE Pennsylvania has won second place in the Forbes Magazine "$200,000,000 Industrial Modernization Contest," it was announced recently at the prize presentation ceremonies held in New York. First prize, the "Modernization Cup," was awarded to International Business Machines Corporation. The award to the Pennsylvania was based on its program for scrapping 32,000 old freight cars and replacing them by 10,000 new all-steel cars of advanced type, thus providing 11,000,000 man-hours of work for employees in the durable goods industries. Upward of $200,000,000 has been invested in plant modernization programs begun or completed this year by approximately 100 corporations which participated in the contest, it was revealed at the prize presentation ceremonies.

New Haven's "Comet" a Year Old

THE New York, New Haven & Hartford's "Comet," streamlined train now making six round trips week days between Providence, R. I., and Boston, Mass., celebrated its first birthday on June 5. During its first year the Comet has traveled more than 133,000 miles; it started originally with five round trips each week day, but beginning last September a sixth round trip was added. On Sundays the train has been used frequently for special excursions which have totaled 12,000 miles. Approximately 100,000 persons have ridden on the Comet.

Double-Deck Trains in Germany

THE Lübeck-Büchen railway in Germany has recently placed in service two two-car double-deck streamline trains hauled by a 2-4-2 type tank locomotive. The new trains, says a description published in a recent issue of the Railway

Gazette (London), are designed for a maximum speed of 74.6 m.p.h. and may be operated without shifting the locomotive from one end to the other; an operator's compartment has been built into the front of the car which leads when the train is running with the locomotive at the rear, and electric remote control apparatus is employed to operate the engine. The passenger seats on the double-deck cars provide accommodations for 258 third-class and 42 second-class passengers. The lightweight cars, which are but little higher than those of normal design, are built of high-tensile steel and the framework is welded throughout; trucks are fitted with roller bearings.

Designing for High-Tensile Steels — Corrections

In Table II in the second column on page 181 of the May issue of the *Railway Mechanical Engineer* the factor of safety at the top of the second column should be 1.813 instead of 1,813.

The second formula near the top of the first column on page 183 should have a decimal point before 52 in the denominator, thus

$$\frac{P}{A} = \frac{15000}{.52 + \frac{1}{16190}\left(\frac{L}{r}\right)^2}$$

In the formula for P/A in the third paragraph in the first column on page 246 of the June issue the factor before L/b in the denominator should be .005 instead of .055.

In the explanation of terms immediately below equation (24) in the second column on page 246 the last item should read:

I = Moment of inertia, in.^{4}

New Equipment

Locomotive Orders

Road	No. ordered	Type of locomotive	Builder
Boston & Maine	3	600-hp. Diesel-elec. switchers	Electro-Motive Corp.
Portland Terminal Co.	3	600-hp. Diesel-elec. switchers	American Locomotive Co.
Southern Pacific	6[1]	4-8-4 passenger	Lima Locomotive Works
	12[1]	4-8-8-2 freight	Baldwin Locomotive Works

Locomotive Inquiries

Road	No.	Type of locomotive	Builder
Central of Brazil	2 or 3	4-10-12	....
Green Bay & Western	3	2-8-2	....
Toledo, Peoria & Western	4	4-8-4	....

Freight-Car Orders

Road	No. of cars	Type of car	Builder
Cornwall R. R.	20	70-ton hopper-ore	Bethlehem Steel Co.
General Chemical Co.	3	50-ton tank	American Car & Foundry Co.
Merchants Despatch, Inc.	500	Refrigerator	Merchants Despatch Trans Co.
Northern Pacific	500	Gondola	Pressed Steel Car Co.
	250	Flat	Company shops
Southern Pacific	250	Auto-box	Mt. Vernon Car Mfg. Co.
	500	Auto-box	General American Trans. Corp.
	500	Box	Pressed Steel Car Co.
	500	Box	Pullman-Standard Car Mfg. Co.
	500	Box	Bethlehem Steel Co.
	250	Box	American Car & Foundry Co.
	200	Flat	Company shops
	100	Gondola	Company shops
Standard Oil Co. of N. J.	6[2]	10,000-gal. tank	Pullman-Std. Car Export Corp.
	5	12,000-gal. tank	General American Trans. Co.
	5	2-comp.—8,000-gal. tank	General American Trans. Co.
Union Pacific	1,000	Underframes[3]	Ryan Car Co.
Wheeling & Lake Erie	500	60-ton twin hoppers	Pullman-Standard Car Mfg. Co.
	500	60-ton twin hoppers	Ralston Steel Car Co.

Freight-Car Inquiries

Road	No. of cars	Type of car	Builder
American Railroad of Porto Rico	7	....	....
Central of Georgia	200	50-ton hopper	....
Chicago Great Western	100	50-ton flat	....
E. I. duPont de Nemours & Co.	1 to 5	70-ton tank	....
International Rys. of Central America	150 to 300	12-ton banana	....
Lehigh & New England	250	50-ton hopper	....
Norfolk & Western	1,000	Box	....

Passenger-Car

Road	No. cars	Type of car	Builder
Southern Pacific	20	80-ft. baggage-horse	St. Louis Car Co.
	Two 12-car trains[4]	Streamline	Pullman-Standard Car Mfg. Co.

[1] To be equipped with Buckeye six-wheel tender trucks.
[2] For service in Brazil.
[3] For 50-ton box.
[4] To be placed in daytime operation between San Francisco, Cal., and Los Angeles about January 1. The trains will be powered with high-speed, streamline steam locomotives, and, complete with reserve motive power, will cost approximately $2,000,000. Each train will include chair cars, a parlor car, a parlor-observation car, a dining car and a tavern car. They will be air-conditioned throughout. The tavern car, which will be a separate unit, will be of unique and original design, with lunch counter facilities at one end and lounge space, equipped to serve refreshments and beverages, at the other. Each train, to be named the Daylight, will have a capacity for 465 passengers.

Supply Trade Notes

Iron & Steel Products, Inc., Chicago, has purchased the North Works of The Ryan Car Company, at Hegewisch, Ill., including buildings and 27 acres of land.

The Metallizing Company of America Inc., Los Angeles, Cal., has opened a new branch office at 407 Call building, San Francisco, under the management of E. T. Parkinson.

J. Carlisle MacDonald has become associated with the executive personnel of the United States Steel Corporation as an assistant to Myron C. Taylor, chairman of the board, in respect to public relations, with headquarters at New York.

The Hutchins Car Roofing Company, Detroit, Mich., and the Chicago-Cleveland Car Roofing Company, Chicago, have merged under the corporate name of the Chicago-Hutchins Corporation, with general offices at 332 South Michigan avenue, Chicago.

The general offices of the Fruit Growers Express Company, the Western Fruit Express Company, the Burlington Refrigerator Company and the National Car Company have been moved from 1259 Munsey building, to 1101 Vermont avenue, Washington, D. C.

E. S. FitzSimmons, manager of sales of the Flannery Bolt Company, Bridgeville, Pa., has been appointed vice-president; W. C. Masters has been appointed sales engineer; Leo Finegan, eastern sales manager, and W. M. Wilson, western sales manager.

The Armstrong Cork Products Company and the Corning Glass Works have entered into a selling arrangement whereby the former will act as sales agent in the equipment insulation field for the latter company's refined wool insulation, consisting of glass fibres.

The Alfol Insulation Company, Inc., New York, has opened Chicago offices in the Field building, 135 South LaSalle Street. D. D. Grassick has been appointed district supervisor in charge of the new Chicago headquarters. Mr. Grassick was formerly in the employ of the Santa Fe in the mechanical and car construction department for 11 years, and from 1926 to 1931 was railway and industrial sales manager of the Insulite Insulation Company. Since 1932 he has been located at Cleveland as transportation sales representative of the Philip Carey interests.

John C. Stewart, supervisor of insulation sales of the United States Gypsum Company, with headquarters at Chicago, has been promoted to manager of railroad sales, with the same headquarters, the department being newly created to coordinate the merchandising and servicing of United States Gypsum products to railroads.

George I. Fisher, for the past eight years with the Haskelite Manufacturing Corporation, has joined the new Technical division of the Algoma Plywood & Veneer Company, Algoma, Wis., with duties as an engineer, also sales promotion and advertising work. He will act as direct assistant in the Chicago office to James R. Fitzpatrick under whose direction the Algoma Technical division was recently established. The Detroit, Mich., office of this division is in charge of G. M. Hanrahan.

J. W. Gleason has resigned as general manager of the Knapp Bros. Mfg. Company, Joliet, Ill., to become associated with the Rawlplug Company, Inc., New York. Mr. Gleason was assistant general sales manager of the Kalman Steel Company for five years and sales engineer of the General Fireproofing Company for seven years. Prior to that he was employed by the Northwestern Expanded Metal Company and the Link Belt Company.

William P. Ewing, vice-president in charge of sales of the Superior Steel Corporation, Pittsburgh, Pa., has been promoted to executive vice-president, a newly created office, and has been succeeded by L. W. Briggs, who has resigned as general manager of sales of the West Leechburg Steel Company. David Pryde, manager of works of the Superior Steel Corporation, has been promoted to vice-president in charge of operations.

H. C. McElhone, for the past five years attached to the president's office of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., and who has served in various capacities in the works, headquarters sales, stock control and executive departments, has been appointed assistant to vice-president. During recent months Mr. McElhone has been in charge of Westinghouse Golden Jubilee Year activities.

Paul D. Mallay has been appointed manager of the Insulation Division, eastern district, of the Gustin-Bacon Manufacturing Company, Kansas City, Mo. Mr. Mallay was for many years chief engineer of the Transportation Department of the Johns-Manville Sales Corporation and subsequently vice-president of the Geo. A. Nicol Corporation. The eastern headquarters of the Gustin-Bacon Company are at 401 North Broad street, Philadelphia, Pa.

The Safety Car Heating & Lighting Company, New York, has announced the following personnel changes: Charles W. Walton, for 23 years secretary and treasurer of the company, at his own request relinquishes the responsibilities of those positions and, after 35 years of continuous service to the company, retires from active business. Herbert K. Williams, assistant to president, has in addition been elected secretary, his headquarters remaining at New York. William Stewart, assistant secretary and assistant treasurer, has been elected treasurer and assistant secretary, with headquarters remaining at New Haven, Conn. John H. Michaeli, formerly assistant to vice-president of Safety Refrigeration, Inc., a subsidiary of Safety Car Heating & Lighting Company, has been elected assistant secretary and assistant treasurer, with headquarters at New York. In addition to the above corporate changes, the following also became effective July 1: H D. Donnell, representative at San Francisco, Cal., has been appointed manager of the Pacific Coast sales district with headquarters remaining at San Francisco. Joseph E. Haskett, who has been attached to the headquarters staff in New York, has been transferred to the Pacific Coast sales district, with headquarters at San Francisco. Arthur R. Hamilton, representative in the Chicago sales district, is transferred to New York as assistant to Mr. Williams, and Eugene Leherissey, formerly with the engineering and inspection department at the New Haven Works, is transferred to the Chicago sales district, with headquarters at Chicago.

Karl Herrmann, vice-president and general manager of the Bantam Ball Bearing Company, South Bend, Ind., has retired, and has been succeeded by A. H. Frauenthal, assistant general manager. Mr. Frauenthal entered the employ of the Bantam Company in 1930, previous to which time he had been quality engineer of the Studebaker Corporation and chief inspector and metallurgical engineer of the Chandler Motor Company. Since entering the employ of the Bantam Company he has served as sales engineer, divisional manager in charge of sales engineering and manufacturing and assistant general manager.

A. H. Frauenthal

Mr. Herrmann is retiring in accordance with plans made when the Bantam Ball Bearing Compnay was consolidated with the Torrington Company. He will be retained as a consulting engineer. He entered the employ of the Bantam Company in 1929 as vice-president and general manager, prior to which he had had over 30 years' experience in engineering, approximately 20 years of which was with the Studebaker Corporation. Mr. Herrmann plans to re-enter some phase of the automotive field.

Karl Herrmann

E. R. Packer has resigned his position as mechanical engineer of the Q & C Company, New York, and has been appointed assistant to the president of The Rails Company, with headquarters at New Haven, Conn. Mr. Packer has served his apprenticeship in both shop and foundry practice and was consecutively draftsman, chief draftsman, estimator and sales engineer. He has been for a number of years identified with the railway supply business, specializing in locomotive, car, and track devices, which are now extensively used. He has had wide experience in the development of snow-fighting equipment, including snow flangers and plows, and electric heaters for railway switches and third rails. He has devoted much time to forced feed mechanical lubrication for locomotives and has contributed improvements in this field. In his association with The Rails Company, Mr. Packer will continue in the development, promotion, and sales of devices to serve the same general field with which he has been so closely associated.

Obituary

Robert E. Belknap, at one time sales agent for the Bethlehem Steel Company at Chicago, died in Boston, Mass., on June 4.

W. A. Champieux, superintendent of the Illinois-Southern district for the Ox-weld Railroad Service Company, with headquarters at Chicago, died in that city on June 4 of heart failure.

Joseph Dolar, vice-president of Templeton, Kenly & Co., Chicago, died in that city on May 30 of pneumonia. Mr. Dolar entered the employ of this company in 1906 as a draftsman, and later became works manager, purchasing agent, and in 1914 vice-president in charge of purchases.

John Brunner, consulting engineer of the Carnegie-Illinois Steel Company, Chicago, died in Evanston, Ill., on June 15 after a long illness. Mr. Brunner was born in Sweden on November 22, 1866, and was graduated from the Royal Institute of Technology of Sweden in 1887.

Frederick W. Stubbs, who was mechanical engineer of the Chicago Great Western from 1911 to 1923, died on May 16 at Muncie, Ind. From 1923 to 1926 Mr. Stubbs served as mechanical engineer of the Standard Stoker Company, and later was connected with the A. M. Byers Company. At the time of his death he was mechanical engineer of the Muncie Oil Engine Company, Muncie.

Horace A. Crocker, retired mechanical expert of the Westinghouse Air Brake Company, died May 27. Mr. Crocker was born in Indiana and went to California in 1882 to enter the employ of the Southern Pacific at San Francisco. After 21 years' service as a mechanic, air brake repairman and later air brake inspector, he became associated with the Westinghouse Air Brake Company as inspector at Oakland, in 1903. He was transferred to Los Angeles as representative of the Westinghouse Air Brake Company, and Westinghouse Traction Brake Company, which position he held until he retired in 1933.

(Turn to next left-hand page)

Personal Mention

General

W. J. O'Neill has been appointed superintendent of motive power of the Western Pacific, with headquarters at Sacramento, Cal., succeeding M. B. McPartland.

E. R. Manor, assistant to the general mechanical superintendent of the Northern Pacific, with headquarters at St. Paul, Minn., has had his title changed to general mechanical assistant.

D. J. Sheehan, mechanical assistant to the president of the Chicago & Eastern Illinois, has been appointed superintendent of motive power, with headquarters as before at Danville, Ill., to succeed L. S. Kinnaird, who has retired. Mr. Sheehan is a native of Northampton, Mass., and was

D. J. Sheehan

graduated in mechanical engineering from the University of Michigan in 1920. From the time of his graduation until 1923 he served as an instructor in the mechanical engineering department of Purdue University. He then entered the engineering department of the Lima Locomotive Works, Lima, Ohio, where he remained until 1928, when he entered the service of the Erie as special engineer to the mechanical assistant to the president. In July, 1929, he was appointed special engineer to the mechanical assistant to the president of the Chesapeake & Ohio, and in 1932 was appointed engineer of motive power of the Advisory Mechanical committee of the Chesapeake & Ohio, the Erie, the New York, Chicago & St. Louis and the Pere Marquette, with headquarters at Cleveland, Ohio. Later in the same year Mr. Sheehan became mechanical assistant to the president of the C. S. & I. with headquarters at Danville.

Eugene H. Roy, whose appointment as general superintendent motive power for the Seaboard Air Line, with headquarters at Norfolk, Va., was noted in the June *Railway Mechanical Engineer*, was born on August 14, 1883, at Winooski, Vt. Mr. Roy entered railway service in November, 1905, as a machinist for the Boston & Maine at Worcester, Mass., and the following year went with the Florida East Coast, serving as a machinist at St. Augustine, Fla. In August, 1907, he became a machinist for the Seaboard Air Line at Jacksonville, Fla., serving successively with that road as night enginehouse foreman at Jacksonville, general foreman at Tampa, Fla., and enginehouse foreman at Raleigh, N. C., and at Portsmouth, Va. From May, 1918, to June, 1919, he was in charge of machinists in the United States Navy Yard at Portsmouth. In October, 1919, he became enginehouse foreman for the Virginian at Elmore, W. Va., and from April to August, 1920, was leading machinist and salesman for the Union Iron Works at Berkley, Va. In August, 1920, he reentered the service of the Seaboard Air Line as a machinist at Portsmouth, then becoming general foreman in the locomotive department at Portsmouth. In April, 1922, he became master mechanic at Savannah and in February, 1927, general master mechanic, Western district. On March 1, 1928, he became master mechanic, which position he held successively on the Alabama division, the Alabama and East Carolina division and the South Carolina divi-

Eugene H. Roy

sion. On September 6, 1929, Mr. Roy was appointed superintendent motive power at Savannah and on April 1, 1931, was appointed assistant general superintendent motive power.

P. J. Colligan, general superintendent of motive power of the Chicago Rock Island & Pacific, with headquarters at Chicago, at his own request, has been relieved of the responsibilities of this position but will continue to serve the railroad in a consulting capacity. Mr. Colligan was born on January 24, 1868, at Rock Island, Ill. He first entered railway service with the Rock Island in 1886 as a call boy, later becoming a machinist apprentice. On finishing his apprenticeship in 1890 Mr. Colligan entered the service of the Chicago, Milwaukee, St. Paul & Pacific as a machinist at Savanna, Ill., returning to the Rock Island as a machinist at Horton, Kan., in 1892. He left the Rock Island in 1894, becoming a machinist on the Missouri-Kansas-Texas and subsequently being promoted to general foreman. In 1899 he returned to the Rock Island as a machinist at Davenport, Iowa, and in the following year was promoted to the position of enginehouse foreman, in which capacity he served at various points. In 1904 he became general foreman on the Illinois Central, later being appointed master mechanic at Clinton, Ill. In 1905 he again returned to the Rock Island as machine-shop and gang foreman at Silvis, Ill.,

P. J. Colligan

in 1906 being sent to Chickasha, Okla., as general foreman. In 1907 he was appointed assistant master mechanic at Fort Worth, Tex., and in 1909, master mechanic at Dalhart, Tex. In 1923 Mr. Colligan was appointed superintendent of motive power at El Reno, Okla.; in 1925, was assigned to the position of superintendent of shops at Silvis; on March 1, 1932, was appointed superintendent of motive power at Kansas City, Mo., and on October 1 of the same year, general superintendent of motive power at Chicago.

M. B. McPartland, superintendent of motive power of the Western Pacific, at Sacramento, Cal., has been appointed general superintendent of motive power of the

M. B. McPartland

Chicago, Rock Island & Pacific, with headquarters at Chicago, Ill., succeeding P. J. Colligan, retired. Mr. McPartland, was born on October 3, 1882, at Burlington, Iowa. He received his higher education at

(Continued on next left-hand page)

Purdue University, graduating in 1905. Shortly thereafter he became a special apprentice with the Chicago, Burlington & Quincy, and in 1907 he entered the service of the New York Central as gang foreman in the West Albany (N. Y.) shops. Two years later he became a draftsman on the Rock Island, and in 1910 went with the National Railways of Mexico as mechanical engineer, returning to the service of the Rock Island in 1913 as general foreman in the mechanical department at Cedar Rapids, Iowa. Two years later he was transferred to the Forty-Seventh Street shops, Chicago, and after a short time in this position, was appointed master mechanic at Goodland, Kan. In 1917 he left the Rock Island to become master mechanic of the Denver & Salt Lake, later becoming superintendent of motive power. In 1921 he left the Denver & Salt Lake to become superintendent of motive power of the Western Pacific.

Master Mechanics and Road Foremen

P. R. Frisbee has been transferred as road foreman of engines from Buffalo, N. Y., to the Allegany and Bradford divisions of the Erie, with headquarters at Salamanca, N. Y.

Lawrence Van Schaick has been transferred as road foreman of engines from Salamanca, N. Y., to the New York division of the Erie, with headquarters at Jersey City, N. J.

G. P. Trachta, master mechanic of the Chicago, Burlington & Quincy at Galesburg, Ill., has been transferred to the St. Joseph division, with headquarters at St. Joseph, Mo.

W. E. Beck has been appointed road foreman of engines of the Mahoning division of the Erie, with headquarters at Cleveland, Ohio, succeeding J. J. McNeill, retired.

C. E. Plott, road foreman on the Galesburg division of the Chicago, Burlington & Quincy, has been appointed assistant master mechanic of the Galesburg-Ottumwa divisions, with headquarters at Galesburg, Ill.

Shop and Enginehouse

H. K. LeSure, master mechanic of the Long Island Railroad at Richmond Hill, N. Y., has been appointed general foreman, maintenance of equipment department, New York Division.

A. L. Porter, gas engine expert of the Chicago Great Western at Oelwein, Iowa, has been appointed supervisor of internal combustion engines, with headquarters at Oelwein.

W. L. Gorton, district road foreman of engines and fuel supervisor of the eastern district of the Erie, with headquarters at Jersey City, N. J., has been appointed supervisor of fuel and locomotive operation of the Erie, succeeding J. E. Ingling, deceased.

Car Department

J. Grant, car foreman of the Canadian National at Dauphin, Man., has retired.

C. R. Stokes, car foreman of the Canadian National at Brandon, Man., has been transferred to the position of car foreman at Atikokan, Ont.

J. Lambert, car foreman of the Canadian National at Redditt, Ont., has been transferred to the position of car foreman at Brandon, Man.

C. A. Abbott, district car foreman of the Canadian National at Edmonton, Alta., has been transferred to the position of car foreman at Edmonton, North.

J. W. Want, car foreman of the Canadian National At Atikokan, Onf., has been transferred to the position of car foreman at Dauphin, Man.

C. G. Morris, car inspector of the Canadian National at Dauphin, Man., has been promoted to the position of car foreman at Redditt, Ont.

Zoel D. Cormier, leading coach carpenter of the Canadian National at Moncton, N. B., has been appointed assistant foreman of the car shops at Moncton.

C. D. Brown, car foreman of the Canadian National at Edmonton North, Alta., has been transferred to the position of district car foreman, with headquarters at Edmonton.

Purchasing and Stores

J. K. McCann, chief clerk of the Chicago, Burlington & Quincy, at the Havelock (Neb.) store, has been appointed inspector of stores at Chicago.

Victor J. Daniels has been appointed division storekeeper on the Southern at Meridian, Miss.

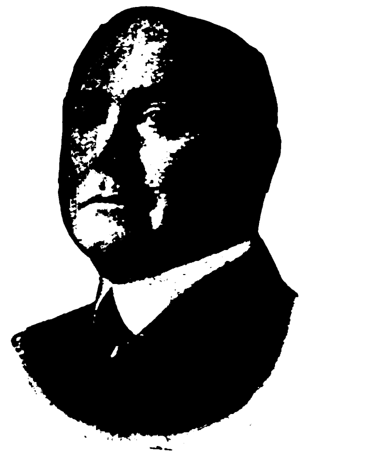
G. A. Goerner, purchasing agent of the Colorado & Southern (a unit of the Burlington System), has been appointed general storekeeper of the Chicago, Burlington & Quincy, with headquarters at Chicago.

Obituary

W. J. Ormsby, master mechanic on the Illinois Central at Freeport, Ill., died suddenly on June 26 of a heart attack, while attending a conference of officers of the railway at Chicago.

J. G. Warnecke, division storekeeper of the Markham storehouse (Chicago) of the Illinois Central, who had been on a leave of absence since late in 1935, died at the Illinois Central hospital at Chicago on June 19. Mr. Warnecke had been a patient at the hospital since he underwent an operation on May 25.

W. G. Black, vice-president in charge of purchasing, stores and mechanical matters of the Chesapeake & Ohio, the New York, Chicago & St. Louis and the Pere Marquette (the Van Sweringen Lines) with headquarters at Cleveland, Ohio, died on June 20 at the Lakeside hospital in Cleveland, after an illness of two months. Mr. Black had been connected with the various units of the Van Sweringen Lines for about 37 years. He was born on April 19, 1877, at Lima, Ohio, and after a public school and business college education entered railway service in 1893 as a machinist apprentice at the Stony Island (Chicago) shoos of the Nickel Plate. Four years later he left railway service to continue his education at Armour Institute of Technology, Chicago, where he took a post graduate course in mechanical subjects. After the completion of his studies he returned to railway service as a machinist at the Burnside (Chicago) shops of the Illinois Central, and from 19[illegible] to 1903 was employed at the South Chicago plant of the Illinois Steel Company (now part of the Carnegie-Illinois Steel



W. G. Black

Company), then returning to the Nickel Plate as a machinist. Subsequently he became machine shop foreman, and in 19[illegible] was promoted to enginehouse foreman at Fort Wayne, Ind. On January 1, 19[illegible], he became master mechanic at the Stony Island shops, where he remained until February, 1923, when he was appointed superintendent of motive power of the Nickel Plate and Lake Erie & Western districts of the Nickel Plate, with headquarters at Cleveland. On January 1, 1927, his jurisdiction was extended to include the entire Nickel Plate system, and in the following month he left this company to go with the Erie as mechanical assistant to the president, with headquarters at Cleveland. He remained with the Erie until 1929 when he became mechanical assistant to the president of the C. & O. Subsequently his jurisdiction was extended to include the Pere Marquette. In 1931 he was appointed assistant vice-president of the C. & O. and the Pere Marquette, with jurisdiction over purchases and stores matters. In March, 1933, he was appointed also to the same position on the Nickel Plate, and on April 17 of the same year was appointed vice-president of these roads in charge of purchasing, stores and mechanical matters. At the time of his death Mr. Black was vice-chairman of Division V—Mechanical, Operations and Maintenance Department, Association of American Railroads, to which he was elected at the 1935 annual meeting. His name had been placed in nomination for the chairmanship of this organization to be voted on at the annual meeting held at Chicago June 25 and 26. Mr. Black was also a member of the General committee of the Purchases and Stores division, A.A.R., past president of the Western Railway Club (1927-1928), and vice-president of the International Railway Fuel Association (1928-1935).

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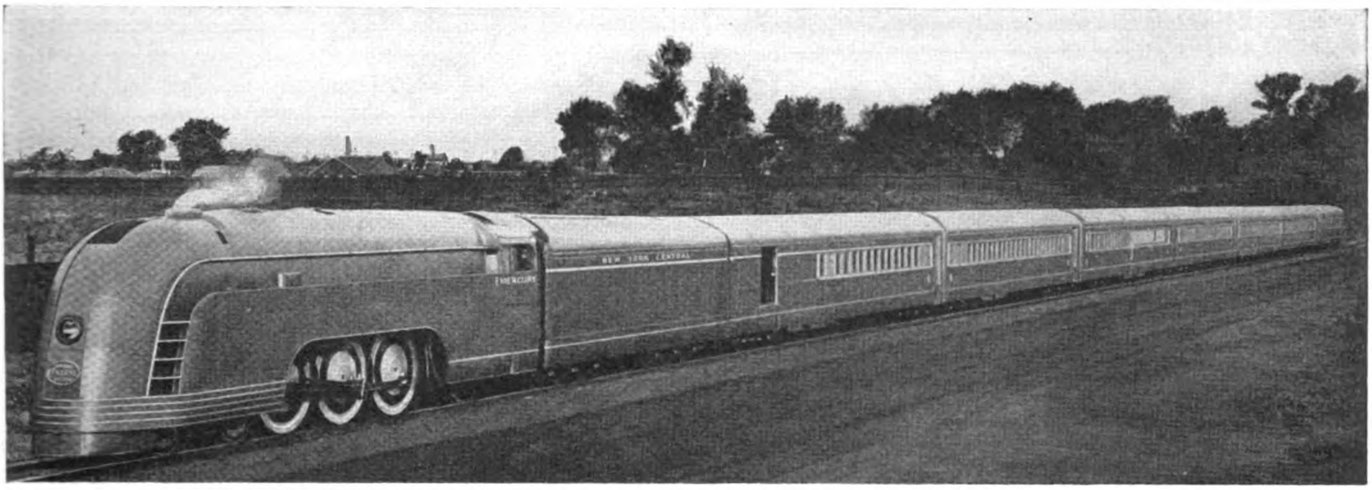
RAILWAY
MECHANICAL ENGINEER



Distinctive Design Features

N. Y. C. Train "The Mercury"

On June 25 the New York Central christened its new Cleveland-Detroit high-speed, streamline, steam train "The Mercury" at its Beech Grove, Indiana shops, where the train was built. The Mercury, which consists of seven coaches, two of which are fitted for Pullman parlor-car service, represents a complete departure from conventional design and embodies changes which combine to produce a train free from the corridor-like appearance characteristic of the interiors of long passenger cars; as well as one which starts and stops with an absence of shocks and in which the riding is smooth and free from vibrations.

The complete interior and exterior of the train, including the exterior of the locomotive, was designed by Henry Dreyfuss, industrial designer, working in close co-operation with the New York Central's equipment engineering department which was responsible for the execution of the designs and for working out all of the mechanical features of the train.

The train is intended for daily round-trip service between Cleveland and Detroit, on which it was inaugurated on July 15. The distance between terminals is 164 miles and the run each way will require 2 hrs. 50 min., a schedule speed of 57.9 m.p.h.

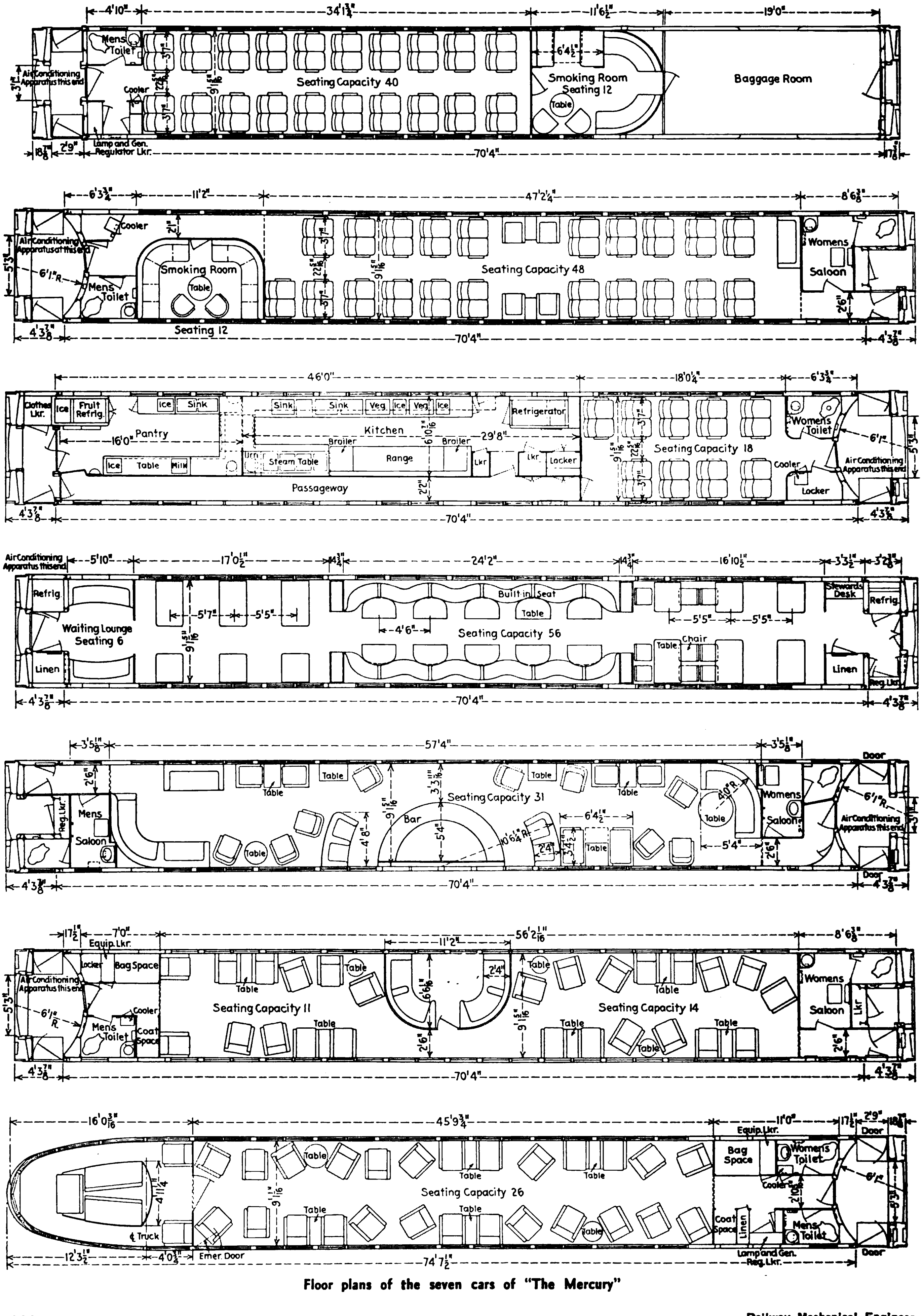
Structural Features

The seven steel cars in The Mercury were originally built for steam suburban service. The design represents an efficient distribution of metal. The coupled length of these cars was 78 feet 11¾ in. and they had a seating capacity of 96 persons, with a weight, ready for service, of slightly less than 54 tons. They were built with turtle-back roofs and without hoods at the ends, the roof sheets extending in a straight line to the intersection with the vestibule end sheets.

The underframes of these cars have 12-in., 35-lb. channel center sills, framed into integral steel platform and body bolster castings at the ends. The cross-members are of pressed steel, with cover plates, and the side sills are rolled angle sections. The end construction consisted essentially of 6-in., 12½-lb. I-beam vestibule end posts riveted into the platform casting at the bottom and tied into the horizontal collision bulkhead over the vestibule. The cars originally had similar body end posts with Z-bar corner and intermediate posts, the former being tied into the platform end castings. The body structure consists of ⅛-in. pressed flanged channel posts, 4 in. deep, with the 3/32-in. outside sheet forming the post covers between the windows. The side plate is a 4-in. rolled Z-bar and the belt rail is of 4-in. by ⅜-in. rectangular section. The roof construction consists of flanged channel carlines of 3/32-in. steel with three pressed-steel Z-shape purlines fitted between the carlines. Below the windows the outside sheathing is of ⅛-in. steel plate, while the post covers and letterboard are of 3/32-in. steel. The roof sheets are of 1/16-in. copper-bearing steel with butt joints over the carlines which were made tight by welding.

The cars were insulated with three-ply ¾-in. hair felt which, except above the windows, covers the entire inside surface of the outside sheathing on the sides, ends and roof and is also used under the floor. Two-ply ½-in. hair felt is applied on the outside surface of the inside finish above and below the windows and one-ply ¼-in. insulation on the inside surface of the letterboard.

In adapting the cars to the new service certain changes



Floor plans of the seven cars of "The Mercury"

were made in both the body and vestibule end construction of some of the cars. At one end of the coach, the kitchen car, lounge car and the first parlor car the vestibule has been closed up and the vestibule space included within the body of the car. No change was made in the vestibule end construction, at these locations the relatively wide end-post spacing of 3 ft. 1 in. in the original cars being considered satisfactory for the new service. In the combination passenger-baggage car at the head end of the train no changes in the end structure were required. The original platform steps were replaced with folding steps in all of the vestibules of the train. These steps, when folded up by the closing of the vestibule trap door, close the space under the vestibule door and form a continuation of the side surface of the car.

All side windows are fitted with double aluminum sash. The outside sash is built in flush with the car exterior and the inside sash is hinged to permit removal for cleaning.

Where the vestibules were closed the alterations involved the removal of the body ends and the addition of a side sill, side posts and floors over the step wells. The collision bulkheads were reinforced throughout the train.

To provide for the observation room at the rear of the second parlor car the entire body structure at the end of the car had to be torn down to the platform casting and rebuilt. The same center construction was retained and reinforced and the body rebuilt with the belt rail dropped 11 11/16 in. to provide windows with openings 3 ft. 9 11/16 in. high (vertical projection) and an unusually wide angle of vision. The end of the car is not only curved in form on the horizontal projection, but is also streamline in a vertical plane as well. This presents a rear end with warped surfaces and the problem of windows around the end of the observation room was a difficult one. This has been worked out, however, in such a way as to avoid completely the use of curved glass, the sash being designed to provide a minimum of interference with the vision of the occupants of the observation room.

The Chanarch construction has been retained, but the composition flooring has been replaced with rectangular cork strips laid in the channel recesses. A layer of ⅜-in. slab cork is then cemented in place in the coaches and corridors where a rubber tile surface is used. Where carpets are laid, ½-in. slab cork is used with the top surface sanded.

The interiors of the cars have been finished throughout with aluminum, including ceilings, sides and partitions, in the application of which spot welding, riveting and screws have been employed.

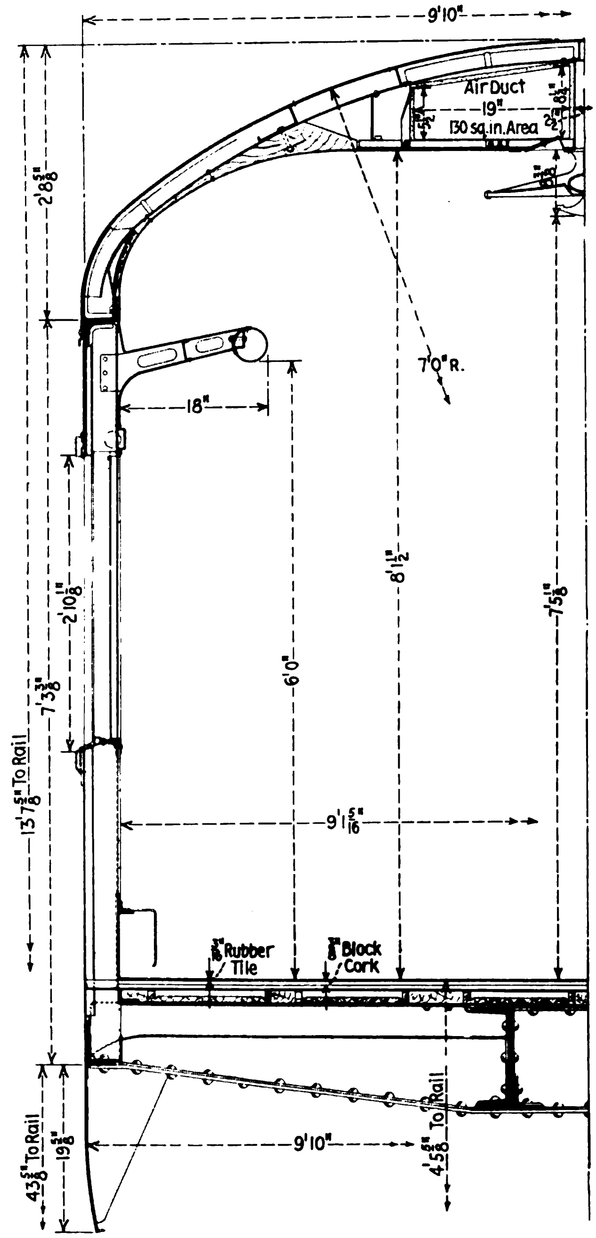
The kitchen and pantry walls and the cupboards are stainless steel. The floors are laid with Alcoa floor plate.

One of the factors in the comfort of passengers is the elimination of diaphragm noise between the cars. This has been accomplished by the use of diaphragms designed and built by the railroad. A patent covering the features of this design has been applied for. The only movement permitted between the diaphragm and the end of the car is the longitudinal compression and the angular movement about a vertical axis necessary to accommodate relative movements of the cars. Lateral movement or torsional movement between cars about a longitudinal axis is taken by the sliding of the lightly loaded face plates on each other.

These diaphragms enclose the entire space between the ends of adjoining cars. The outer surface is formed of sheet rubber.

The Trucks

With the exception of the kitchen car, the cars are all carried on trucks with the original frames and bolsters. They are of the four-wheel double drop-equalizer type, with a wheel base of 7 ft. The rolled-steel wheels are 33 in. in diameter, have conical treads and are mounted on 5-in. by 9-in. axles fitted with Timken roller bearings. Because of the added weight of kitchen equipment, the trucks on the combination kitchen-coach have been increased to 8 ft. wheel base and are carried on 5½-in. by 10-in. axles, also fitted with Timken roller bearings. The elliptic springs are of high-tensile, chrome-vanadium steel, and the helical springs of silicon-vanadium steel. These springs are unusually flexible and contribute materially to the smooth riding qualities of the cars.



A half-section through one of the coaches

The trucks have been fitted with sound-insulating material. Fabreeka pads have been placed on both the top and bottom elliptic spring seats and on top of the coil springs. Rubber pads are inserted between the equalizers and the tops of the journal boxes and between the truck frame and wear plates.

The trucks under the kitchen coach are fitted with American type clasp brakes. Those under the other cars are fitted with Simplex clasp brakes. The cars are equipped with New York Schedule UCB air brakes,

with 16-in. cylinders on all cars except the kitchen car which has an 18-in. cylinder.

Connections Between Cars

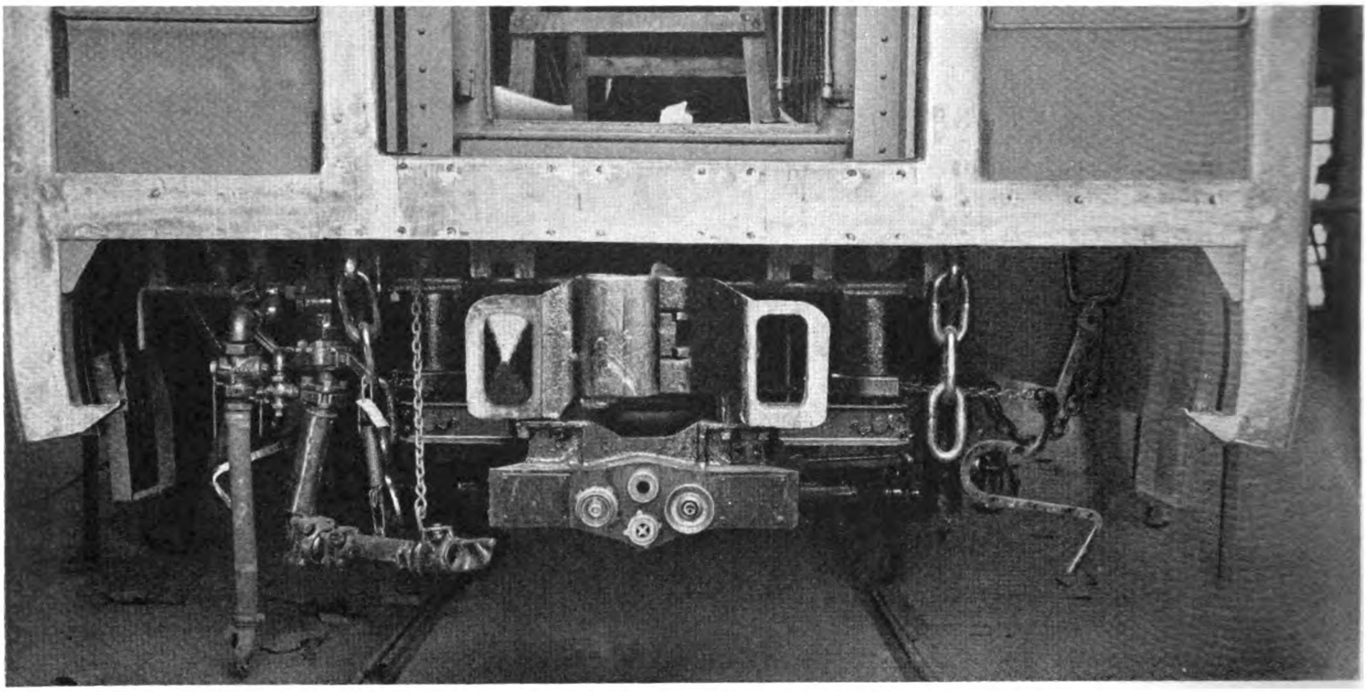
The rear end of the tender and all of the cars, with the exception of the rear end of the observation car, are fitted with O-B Tight-Lock couplers and Waughmat Twin Cushions and buffers. The Waughmat Twin Cushion without the buffer is installed at the rear end of the train. The rear end of the Tight-Lock coupler shank is fitted with the Ohio Brass type of ball connection which is secured in a socket at the front end of the yoke. This provides a free universal movement between the drawbar and the yoke. The coupler carrier provides for spring-cushioned vertical movement of the coupler shank and is fitted with a lateral spring centering device. The standard type of O-B uncoupling mechanism is utilized with levers accessible under each side of the car near the end.

Connector heads are attached to the under side of the Tight-Lock couplers. These provide automatic couplings for the air-brake, air-signal and steamheat train lines throughout the train. The connectors are provided with wings at either side for electrical connections. These, however, are all blanked, except on the couplers between the kitchen and dining car. Here they are fitted to connect the circuits required for the electro-pneumatic operation of the dining-car doors from the end of the kitchen car.

The Waughmat Twin Cushions at each end of the car are made up of two sets of Waughmat concentric springs of Spencer-Moulten rubber, each set consisting of a series of rubber springs and steel plates held between followers.

The Twin Cushions operate against abutments located in the center of the pocket with one Waughmat Cushion bearing against the front face and the other against the rear face of the abutment. The front follower of the forward spring assembly and the rear follower of the rear spring assembly bear against the inside ends of the yoke under an installed compression of about 8,000 lb. These, however, are all blanked, except on the couplers and, therefore, move forward and backward freely with the movement of the yoke. It is evident, therefore, that with the units operating in opposition to each other the balanced assembly is ready to respond to the slightest change in pressure either in pulling or in buffing, since one set of springs expands and unloads as the other is further compressed and loaded by a buffing or pulling force through the drawbar.

The buffer is provided with light springs in order that the pressure between the diaphragms may not be more than is essential to maintain proper contact between faces under all operating conditions. This pressure amounts to about 1,300 lb. with a compression of 2½-in. In addition to the helical springs the buffer includes a series of Waughmat rubber springs which take the heavy buffing loads after the closure of the steel springs.

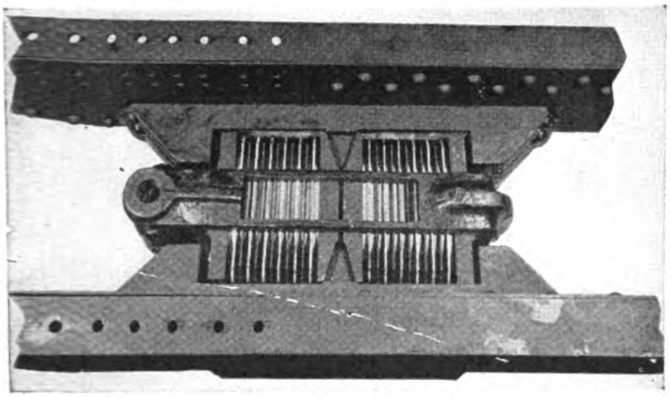


The O-B tight-lock coupler and connector

Interior Facilities

In adapting these cars to the new service the interiors were completely removed and the end structures changed where necessary to close up vestibule side-door and step openings and to accommodate diaphragms which completely enclose the space between the ends of adjoining cars. The train is designed as a complete unit, no two cars being alike in interior arrangement. It provides seats for 106 coach passengers and for 57 persons in the Pullman parlor cars, including six in the parlor-car compartment. There are additional seats for 24 in the two spacious coach smoking rooms. Fifty-six persons may be seated at one time at the tables in the dining rooms, with additional seats for six in a lounge at one end of the diner for those who may have to wait for seats at the tables. A lounge car, with seats for 31 passengers, and an observation room, with seats for 10 persons, are provided for the use of the parlor-car patrons. All seats in the coaches are numbered and coach tickets will be sold up to the seating capacity.

A combination of medium gray, with scratch brush metal trimmings are used on the exterior of the train from the front of the locomotive to the rear end of the parlor-observation car and aluminum panels tie the windows into a single wide band along each side of each car. At night the locomotive running gear is floodlighted

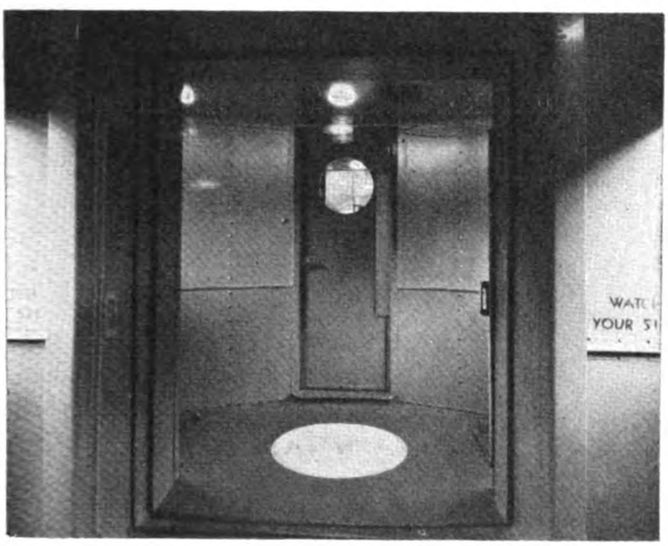


The Waughmat rubber draft gear with a section of the yoke cut away to show its construction

from lamps concealed under the skirt below the running board.

The interior of the train is notable for the variety of architectural treatments employed in the various cars and the way in which a variety of colors has been used. The repetition throughout the train of the colors selected tends to tie the cars together as a unit, although the way in which these colors have been combined varies in the different cars. The colors include tans, browns, musk, rust, bright blue, green, bright red and gray. All the china, silverware and glassware have been designed especially for this train.

The train consists of a combination passenger-baggage car, a coach, a combination kitchen-coach, a dining car, a lounge car with a bar, a parlor car and a parlor-observation car. The coach compartments in the first



The rotunda vestibules are much roomier than usual

three cars all have arched ceilings above the center of which is an air duct of large cross-section. Below the center of the ceiling is supported a wide shallow trough which serves as a diffuser of the conditioned air from the duct above the ceiling and as a reflector of the indirect lighting which furnishes general illumination for the coach interiors.

The under side of the baggage racks is solid and curves into the side wall above the windows. A tubular section at the outer edge of the racks encloses the lights for the individual seat units.

The monotony of the seating arrangement in the second car, which is a full coach, is varied by placing a built-in seat against the bulkhead at the forward end. At approximately the middle of the car on each side are placed two built-in heavily upholstered chairs with a small ebonized table and a reading lamp between. For contrast with the brown mohair of the slats these chairs are upholstered in blue-green mohair.

At the front end of the coach portion of the combination passenger-baggage car is a smoking room with lounge seats, sections and chairs for 12 passengers. At the rear end of the second coach is another smoking room, with seats for 12. To make it equally available to men and women a glass-enclosed opening extends half way across the bulkhead and along the corridor to the door.

Wall sockets are provided in the coaches for tables at all the seats. Both single and double tables are provided, and they can be used to serve meals at the coach seats.

Because of the relatively short trips, both of which include meal hours, it was necessary to provide facilities for serving quickly a large number of passengers. Hence, an unusually large kitchen and serving pantry occupy about two-thirds of the third car and the fourth car is devoted entirely to dining service, seating 56 persons at one time.

The dining room is divided into three sections. The end sections have the customary arrangement of tables and chairs. The middle section is fitted with built-in leather upholstered seats with the backs against the sides of the car and semi-circular tables for two facing on the aisle. The sides and ends of this car are finished throughout in plain quartered walnut Flexwood with the grain running vertically. The ceilings in the end sections are horizontal with a shallow, flat clerestory recess at the center, finished in buckskin tan. Through openings in the sides of the clerestory recess conditioned air enters the car. The lighting is of the louver type, the units being placed transversely across the lower ceiling level over each table location on either side.

In the center section of the dining room the ceiling, also finished in buckskin tan, is carried down in a sweeping curve to the tops of the windows. Below the center of the ceiling, in a wide band of blue, is an air diffuser and indirect lighting fixture somewhat similar to those in the coaches. The seats in this room are upholstered in blue to match the wide band in the middle of the ceiling. The floor throughout the car is covered with carpet with a broken stripe pattern in two tones of rust.

The three sections are separated by double partitions about a foot apart, having clear plate glass above the wainscoting. Between these glass walls on each side of the aisle provision has been made for blooming plants or cut flowers, illuminated by special ceiling fixtures.

The kitchen is 29 ft. 8 in. long and the pantry at the end of the car adjoining the dining car is 16 ft. long. The pantry opens through double doors into a vestibule at the end of the car which is separated from the corridor alongside the kitchen by a door. There is no provision for closing this vestibule at the end of the car. The end of the dining car, however, is closed with double swinging doors, operated electro-pneumatically by an electric eye mounted on the end posts of the kitchen car. Push plates which can be readily operated by the elbow are provided at the end of the kitchen car for alternative use and in the dining car to operate the doors when returning to the kitchen.

A service door is provided at the kitchen side of the car near one end of the kitchen and at the vestibule on the opposite or corridor side.

The car back of the diner is entirely devoted to lounge facilities. In the middle, against one side, is a semi-circular bar backed up by mirror panels extending from the top of the bar to the ceiling, which gives the impression of increased width to the car. Heavily upholstered

loose chairs, built-in settees and sections are conveniently arranged on either side of the bar.

The walls of the parlor cars are finished in walnut Flexwood down to the wainscoting, which is natural cork, of the same tone. The chairs, although generally similar in form, have been upholstered in a variety of colors and fabrics. There are rectangular lamp tables in walnut and movable circular tables having black Formica tops, with Alumilite metal bases, and trim. The lighting of the parlor cars is provided by troughs along the sides placed at the base of the ceilings. These are arranged to provide indirect lighting from the ceilings and direct reading light at the chairs through louvers at the bottom.

In the first parlor car the outside walls of the semi-circular compartment in the middle of this car are finished with a photo-mural in cloud effect. The location of the compartment itself and the possibility for some variation in the arrangement of the loose chairs relieves the corridor-like effect of a long, unbroken interior.

The observation room at the rear of the second parlor car represents a marked departure from the customary arrangement of such compartments in two respects. Instead of arranging chairs about the sides of the room a fixed center settee has been built in with seats for three persons on each side facing toward the windows and with seats for two persons at the rear end facing directly toward the windows in the end of the car. Two additional chairs are provided, one at each side against the glass partition which separates this room from the main compartment of the car, both thus facing toward the rear. The other respect in which this room departs from American custom is in the lowering of the window sills approximately one foot below the standard height throughout the rest of the train.

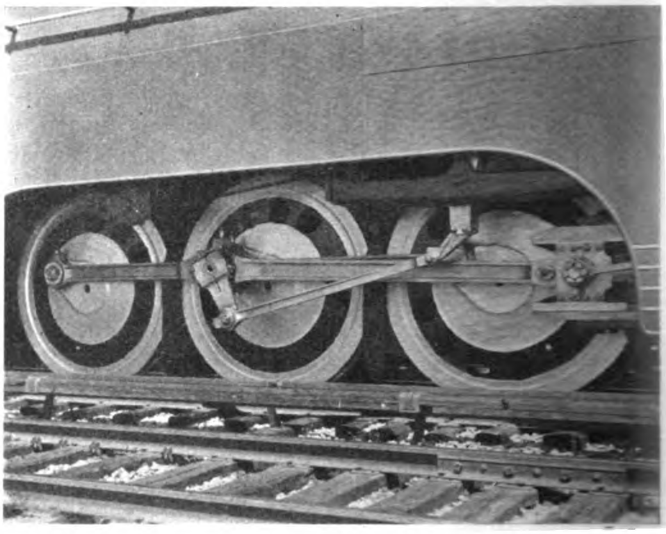
A roomy bag locker is provided in each of the two rear cars. These lockers, fitted with deep shelves, provide for the checking of hand luggage by the porter. The lockers are closed by a roller curtain of aluminum. Across the aisle from each baggage locker is a recess fitted with hangers for the storage of coats or wraps.

With the exception of the dining car, which has none, there is a single vestibule at one end of each car. Those in the second and third cars and in the two parlor cars adjoin each other and in each case have been treated so that, together, they form an unusually spacious lobby between the cars.

In carrying out this scheme the vestibule end posts have been changed to give a clear passage between cars of 5 ft. 3 in. and the body ends have been replaced with walls built on a circular arc. The effect is to create a rotunda from which open the vestibule side doors and the doors into each car. The vestibule at the front end of the club car, next to the diner, is similarly treated, except that because of the absence of an adjoining vestibule, the spacing of the end posts was not changed from the original of 3 ft. 1 in. The vestibule at the rear end of the first car is of conventional form.

Lighting

The beauty of the train is greatly enhanced by the lighting system, which performs the dual function of serving as decoration and also giving adequate, well-distributed illumination. The overhead lighting in the main sections of the first three cars consists of continuous indirect ceiling fixtures. A row of 15-watt lamps on 10-in. centers along the ceiling is screened from view by a continuous suspended baffle which reflects light to the ceiling. An opening along the center of the baffle permits light to escape downward to a secondary baffle, which illuminates the bottom of the upper structure, and at the same time re-directs the air from the air-conditioning system.



The driving wheels are finished in aluminum and black and are illuminated at night

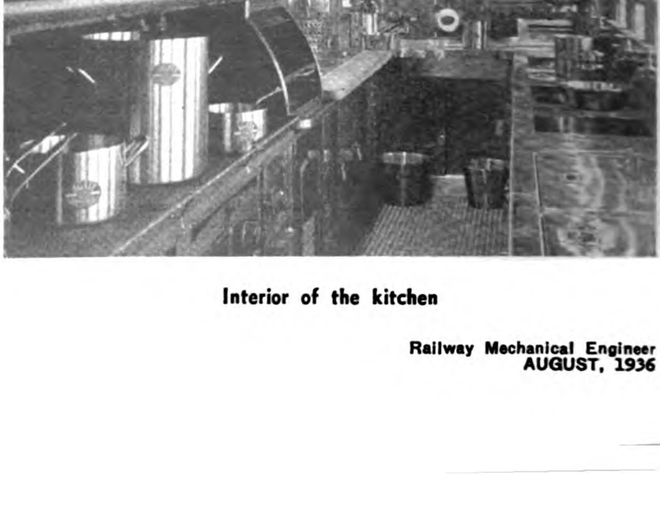
Reading light for seated passengers in the main sections of these car is supplied by baggage-rack fixtures. The units are located in a tube forming the outside roll edge of the baggage rack, with a 60-watt T8½ lamp over each seat. Transverse louvers at the bottom of the fixture protect the passenger from direct view of the light sources. Each light is controlled individually by a toggle switch.

The baggage compartment of the first car is lighted by three 50-watt and one 25-watt ceiling fixtures. The smoking room in this car receives light from two 50-watt and four 25-watt fixtures. These are located in an air-diffuser plate.

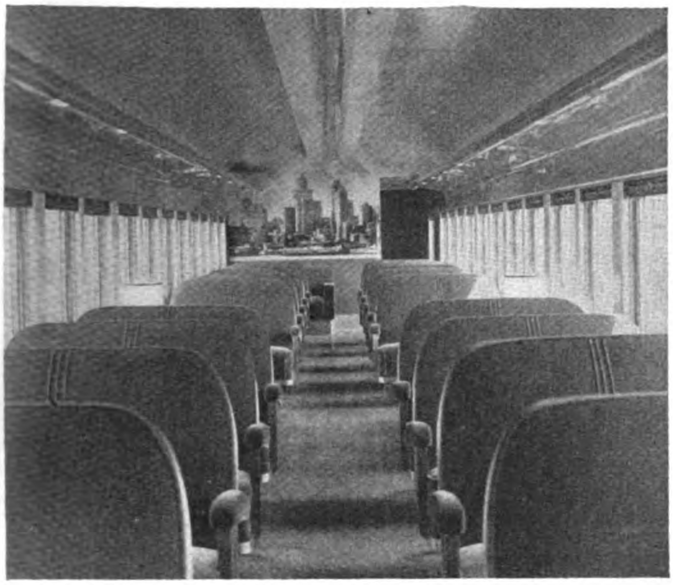
In the kitchen and pantry sections of the kitchen car, vapor-proof units are used. There are nine 50-watt and eleven 25-watt units.

In the center section of the dining car, two continuous indirect lighting troughs are installed. These units include 80, 15-watt lamps on 7-in. centers. The end dining sections are lighted by louvered flush diffusing panels, which extend from the side wall to the raised center portion of the ceiling. There are 12 of these units, each equipped with one 25-watt and one 50-watt lamp.

The semi-circular bar in the lounge car is lighted by



Interior of the kitchen



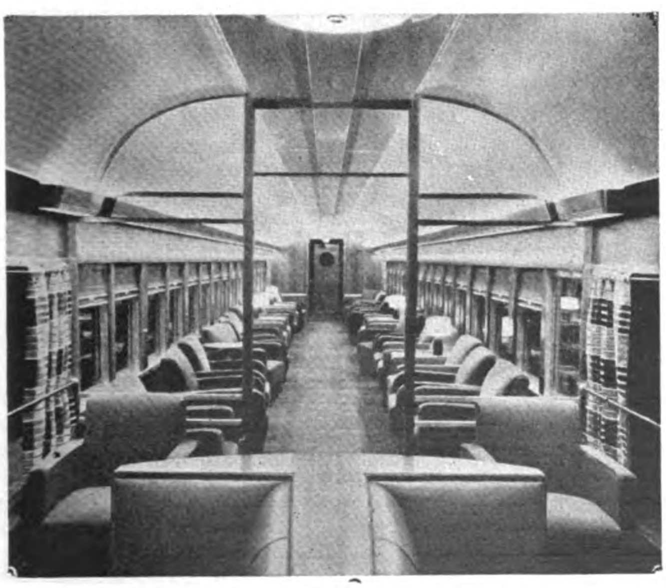
Interior of second coach showing one of the murals

eight 25-watt lens-type units, which direct a strong light downward onto the bar. Indirect illumination is also provided inside the bar by means of twelve 10-watt lamps mounted in a semi-circular trough suspended just below the ceiling. The semi-circular row of direct

Light Weights of the Cars of The Mercury

Passenger baggage car	125,240 lb.
Coach car	126,100 lb.
Kitchen-coach car	148,520 lb.
Dining car	123,280 lb.
Lounge car	124,320 lb.
Parlor car	123,700 lb.
Observation-parlor car	122,260 lb.

lighting units and the indirect fixture are reflected in the mirror back of the bar to give the illusion of complete concentric circles. The sections on either side of the bar are more softly illuminated by continuous inverted trough, direct units, fitted with 132 10-watt S-11 lamps on 10-in. centers. The under side of the trough is fitted with transverse louvers, which direct the light downward and conceal the lamps. The side louver lighting is augmented by the two circular louvered ceiling units, one at either end of the car. These are each equipped with one 100-watt lamp.



Looking forward from the observation room

In the summer when lighting requirements are at a minimum and power is required for air conditioning, the 25-watt lamps in the louvered fixtures will be replaced with 15-watt lamps. When these are used, the lighting intensity on the 45-deg. reading plane is 6 foot candles. In this way the large air-conditioning generators are used in off season to provide high lighting intensities which are more desirable, especially in the winter months.

The wide vestibules are lighted by two 25-watt and one 50-watt lens-type units. An intensity of 4½ foot candles is obtained at the edge of the platform and 2½ foot candles on the bottom step. Lens-type units are also used as locker lights and passageway lights at many locations throughout the train.

General lighting in the men's and women's saloons is supplied by one or two lens-type units. The mirrors in these rooms have horizontal recessed reflectors at the top and bottom, fitted with 30-watt Lumiline lamps. Three of the women's rooms are also equipped with built-in vanity table fixtures.

Four vertically-mounted fixtures, each containing two 30-watt Lumiline lamps, are used to light the waiting lounge at one end of the dining car.

Sixty-volt Mazda lamps are used throughout the train. This is a special rating, the 60-volt, rather than 64-volt lamps being chosen to insure that the lamps burn at full brilliancy when they are receiving their power from the battery, when the generator is not running.

Back-up and marker lights are built into the rear of the parlor-observation car, the latter having a mechanism for changing colors. The rear sign is lighted by seven 25-watt lamps, arranged in two rows.

Circuit breakers are used to protect and control lighting circuits. Toggle switches are used for individual lights. Door switches are used in lockers having lights and in refrigerators.

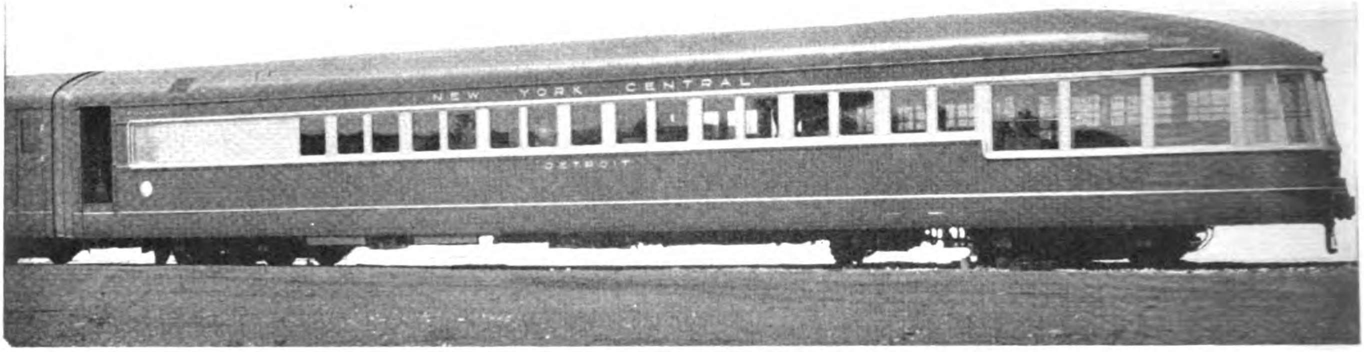
Air Conditioning

All cars are air-conditioned throughout for year-round operation, the electro-mechanical system being used. Each car is supplied with a 6-ton Frigidaire compressor, driven by a 15-hp. a.c.-d.c. motor mounted under the car. The evaporator with blower and intakes is placed in the ceiling at one end of the car. The blower is driven by a ¾-hp. motor. The re-circulated air intake is located in the passageway ceiling. Outside air intakes are placed in the ceiling of the vestibules, except in the dining car, where the outside air intake is placed in the vestibule end construction.

Air distribution has been worked out, so that ducts and other passages are concealed and combined with lighting fixtures, in such a way as to provide the desired circulation without interference with the interior appearance or decoration scheme. Exhaust fans are provided, one in each of the toilets and the smoking rooms in the passenger baggage car and coach; the compartment in the parlor car, the stewards section and the regulator locker of the dining car and the pantry of the kitchen coach. Two are provided in the kitchen of the kitchen coach and the observation section of the parlor-observation car. These fans insure proper ventilation without permitting the infiltration of outside air. Two motor-driven blowers supply draft for the range.

Other motor-driven equipment includes a kitchen mixer with accessories, including a juice extractor used in the kitchen and a drink mixer used at the bar.

Each car is equipped with a 20-kw., 80-volt, body-hung generator, driven from an axle through a Spicer positive gear drive having a ratio of 2.54:1. There are two 16 cell, 600-amp.hr. lead batteries, connected in series, per car. Standby power can be received both as 220-volt, three-phase, a.c. power for operating the com-



The streamlining at the rear of the train

pressor motors and as 80-volt, direct-current power for charging batteries. There are two d.c. and two a.c. receptacles on each car, one set on each side.

The Locomotive

The locomotive, which by its streamlining and decoration is an integral part of the train, is a K5 Pacific type locomotive of a design developed in 1926. It develops a maximum tractive force of 37,600 lb. The cylinders are 25 in. in diameter by 28 in. stroke; the driving wheels, 79 in. in diameter, and the boiler pressure, 200 lb.

General Dimensions and Weights of the New York Central "Mercury" Locomotives

Railroad	New York Central
Builder	American Locomotive Co. (Streamlined at N.Y.C. West Albany shops)
Type of locomotive	4-6-2
Rated tractive force, engine, 85 per cent, lb.	37,600
Weights in working order, lb.:	
On drivers	193,800
On front truck	66,300
On trailing truck	56,900
Total engine	317,000
Tender	292,300
Wheel bases, ft. and in.:	
Driving	13—8
Engine, total	36—11
Engine and tender, total	79—5½
Driving wheels, diameter outside tires, in.	79
Cylinders, number, diameter and stroke, in.	2—25 by 28
Valve gear, type	Walschaert
Boiler:	
Steam pressure, lb.	200
Diameter, first ring, inside, in.	79½
Firebox, length, in.	108⅛
Firebox, width, in.	90¼
Tubes, number and diameter, in.	190—2¼
Flues, number and diameter, in.	45—5½
Length over tube sheets, ft.	21
Fuel	Bituminous coal
Grate area, sq. ft.	67.8
Heating surfaces, sq. ft.:	
Firebox	222
Arch tubes	35
Firebox, total	257
Tubes and flues	3,695
Evaporative total	3,952
Superheating	1,150
Combined evaporative and superheating	5,102
Tender:	
Style	Cast-steel frame
Water capacity, U. S. gal.	15,000
Fuel capacity, tons	16
Trucks	Six-wheel

This locomotive was refitted at the West Albany shops, at which time the drivers were replaced with wheels of the Boxpok type, and the entire locomotive and tender fitted with a streamline cowling to harmonize with the exterior of the coaches. The driving-wheel centers have been painted in aluminum. A band of black separates the central aluminum discs from the aluminum finished rim and tire.

The lighting on the running gear of the locomotive is supplied by three 50-watt and two 15-watt lamps on either side, located under the cowling immediately above the driving wheels. Power is supplied by a 32-volt, 1,000-watt turbine-driven generator.

The principal dimensions of the locomotive are given in tables accompanying the text.

U. P. to Build First Steam Turbine Electric Locomotive

The first steam turbine electric locomotive to operate on an American railroad will be constructed by the Union Pacific and the General Electric Company, this action being one of the first developments of the recently formed research department of the railroad. The locomotive will consist of two 2,500-hp. self-contained units, which can be operated individually or in synchronization and will be capable of a maximum speed of 110 m.p.h. with a trailing load of 1,000 tons. Delivery is expected early in 1937. The design of the locomotive is such that by operating both units it will be possible to maintain the schedules of the Los Angeles Limited, The Challenger or other limited trains in transcontinental service. With either unit it will be possible to maintain the schedule of the Streamliner City of Denver.

The weight of the new locomotive will be approximately 20 per cent less than that of a conventional steam locomotive, and lighter than the Diesel-electric locomotives now used on Union Pacific streamliners. It will use fuel oil of approximately the same grade as that used for the conventional oil-burning steam locomotives and will also be equipped to use distillate.

Each of the units will be of the 4-6-6-4 type, the size of the wheels being 36 in.-45 in.-45 in.-36 in., respectively. The locomotive will have fuel and water capacity for continuous operation for a minimum of 550 miles without refueling. The steam turbine of each unit will be connected directly to a 225-kw., three-phase, 60-cycle, 220-volt generator, which will provide electricity for the six traction motors, one of which will be mounted on the axle of each pair of the six driving wheels on each unit.

GET OFF AND PUSH—W. G. Besler, chairman of the board of the Central of New Jersey, sends in a reproduction of a ticket issued by the Elizabethtown & Somerville about 1848, which contains the following provision: "The passenger to assist the conductor on the line of road whenever called upon." Mr. Besler also recalls that an old-timer once informed him that, on rainy days on a summit on the Chicago, Burlington & Quincy in Missouri, it was the regular practice to require all male passengers to stand on the car steps going over the hill and, if the locomotive stalled, it was their duty to hop off and push.

Locomotive

Front-End Arrangement*

Successful method for redrafting locomotives by modification of Master Mechanic's front end

A PROPOSED new standard method of drafting steam locomotives, based on a proper proportioning to each other of the gas areas over the brick arch and throughout the smokebox is indicated on the proposed recommended practice, Sheets 1 and 2. Employing the same general arrangement of the smokebox details and adhering basically to the design known as the "Master Mechanics" front end, as described in the 1906 Proceedings of the American Railway Master Mechanics Association, the proposed method has been developed from an analysis of data secured from standing and road test results while redrafting various classes of bituminous coal burning locomotives of conventional design in a wide variety of service and using all the common kinds and mixtures of bituminous coal.

The details of the smokebox and arrangement of the "Master Mechanics" front end design consist of an exhaust stand with round-bore exhaust nozzle, smokestack and stack extension bolted together, a diaphragm plate or vertical back deflecting plate, a table plate supported by the exhaust stand and attached to the diaphragm plate and sides of the smokebox, an adjustable draft sheet attached to the table plate, and smokebox netting attached to the table plate and the interior of the smokebox and usually applied in a sloping position.

From a study of the gas areas of properly drafted locomotives and observations made while redrafting, it was discovered that there is a definite and necessary relation of these areas to each other and that this relation is practically identical on all the locomotives redrafted. It has been considered logical therefore, to use one of these areas, namely, the minimum net gas area through the tubes and flues, as an index to which the other gas areas, including the minimum area of the smokestack, should be compared and proportioned.

Comparison of stack diameters determined by the method recommended with the diameters of existing stacks or stack diameters determined by other methods in general use discloses in a majority of cases that larger stacks may be used. The use of larger stacks permits the use of larger exhaust nozzles with subsequent reduction in back pressure. Reduction in back pressure, when accompanied by satisfactory steaming qualities and fire conditions, results in a saving of fuel. Other advantages of reduced back pressure are increased drawbar pull and a reduction in the maintenance costs.

While this discussion is devoted particularly to redrafting existing locomotives, the method outlined is equally applicable to new locomotives, and the designs for brick arch and smokebox details of a new locomotive may be developed in accordance with the plan as soon as the minimum net gas area through the tubes and flues is known.

As the principles and method of drafting recommended have been gathered from tests made with locomotives equipped with grates having 20 to 30 per cent effective air opening, it is possible that minor changes in some proportions may be necessary to obtain satisfactory results when drafting locomotives having grates with net air opening not within these limits. The recommended practice will, however, serve as a guide and such changes in proportions as may be found necessary as a result of tests should then be made a part of the method.

Fig. 1 illustrates the recommended arrangement of smokebox details, with recommended gas areas and other pertinent data. Fig. 2 illustrates the recommended brick arch design, together with recommended net area of the opening between the back end of the arch and the crownsheet.

The following paragraphs and included diagrams cover the design of the various smokebox details and include a discussion of the analysis of gas areas, gas passages in the smokebox, assembly of smokebox details, study of the drafts and tests to determine locomotive and fuel performance.

Analysis of Smokebox and Firebox Design

When preparing to redraft a locomotive or make changes to improve steaming qualities, the first step is to calculate and tabulate actual gas areas. These may be calculated in square inches and are as follows:

1—Net area between top of brick arch and crownsheet at rear end of arch.
2—Minimum net gas area through tubes and flues.
3—Maximum area under table plate.
4—Minimum net area under table plate (opposite exhaust stand and steam pipes).
5—Area under draft sheet.
6—Net area through smokebox netting.
7—Area of smokestack at minimum diameter.

In tabulating the gas areas a graphical chart such as Fig. 3 is recommended. The minimum net gas area through the tubes and flues is used as the base for plotting the other areas and is rated at 100 per cent. A percentage tabulation of the other areas is also given.

GAS AREAS-PERCENT OF MINIMUM NET AREA THRU TUBES AND FLUES

AREA	PERCENT OF MINIMUM NET GAS AREA THRU TUBES AND FLUES	
	PREFERRED	PERMISSIBLE LIMITS
A	25	25 TO 27
B	130	110 TO 140
C	85	80 TO 95
D	75	65 TO 80
E	95	95 TO 110

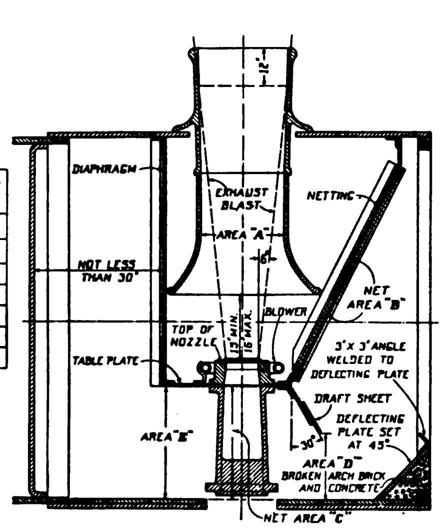


Fig. 1—Smokebox arrangement

* Abstract of a sub-committee report included in the general report of the Committee on Locomotive Construction at the meeting of the Mechanical Division of the A.A.R., Chicago, June 25 and 26, 1936.

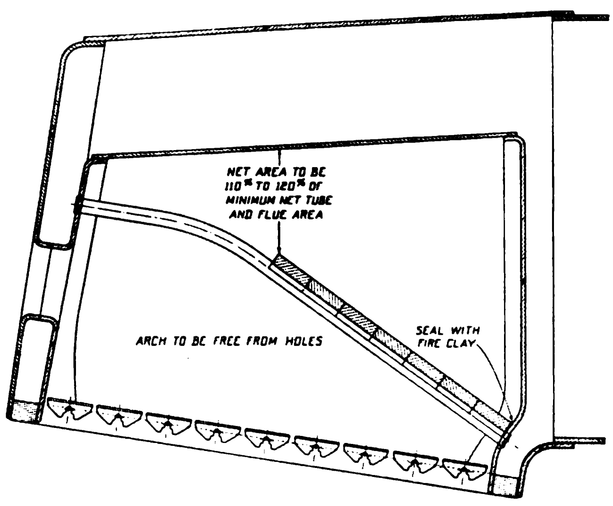


Fig. 2—Brick arch arrangement

Each chart should carry such important data as locomotive classification, size of stack, etc. A typical group of actual gas areas for a U. S. R. A. Mikado type locomotive are shown in Fig. 3.

Recommended Gas Areas

Recommended gas areas are illustrated in Fig. 4 as a percentage of the minimum net gas area through the tubes and flues. The areas shown form the basis of the proposed new method of drafting and have been successfully employed in redrafting several hundred locomotives. Many new locomotives drafted to these proportions have been placed in service and operated under varying conditions without any change in smokebox details.

In Fig. 4 there is a gradual stepping down in the preferred areas from the area over the arch to the area under the draft sheet. While this condition is ideal it will be found necessary in some cases to have the maximum area under the table plate somewhat in excess of the minimum net gas area through the tubes and flues in order that the minimum area under the table plate shall not be less than under the draft sheet. Where this condition exists it has been found that the draft sheet loses most of its value as a regulator of the drafts.

Application of the recommended proportions to the locomotive for which the actual gas areas are tabulated in Fig. 3 permitted an increase in stack diameter from 17 in. to 20 in. This, in turn, made it possible to increase the exhaust-nozzle diameter from 7 in. to 8 in. with entirely satisfactory results and with a substantial saving in fuel.

Important Gas Passages in Smokebox

Space Between Front Flue Sheet and Diaphragm Plate.—Not infrequently on some older locomotives it is found that the diaphragm plate is less than 30 in. ahead of the front flue sheet. This condition is usually responsible for excessive heat at the firedoor. In exaggerated cases the flames in the firebox have a tendency to roll and not move freely over the brick arch. In all cases where the diaphragm plate is less than 30 in. ahead of the front flue sheet it is recommended that the diaphragm be sloped forward at the bottom from a point in line with the bottom of the superheater header. The total amount of slope will usually be determined by the distance between the exhaust stand and the diaphragm and should not exceed 15 in. Where the flare of the smokestack interferes with obtaining the desired slope in the diaphragm a small portion may be cut off the flare without harmful effects. The portion of table plate projecting backward beyond the new location of the diaphragm plate should be cut off as shown in Fig. 5. On some modern locomotives a reverse condition is encountered and the diaphragm plate is an excessive distance from the front flue sheet. With smaller locomotives this may be responsible for difficulty in obtaining sufficient draft. Where such an effect is recognized it has been found helpful to install an additional diaphragm plate in back of the existing plate and approximately 36 in. ahead of the front flue sheet. The table plate should be extended over to the extra diaphragm and the compartment thus formed made air tight. See Fig 6. The superheater damper is located in the passage between the front flue sheet and diaphragm plate. Some roads have removed all superheater dampers while others have retained them. It is not intended to approve or criticize either practice. However, it has been noted that drafting of locomotives by the method described has

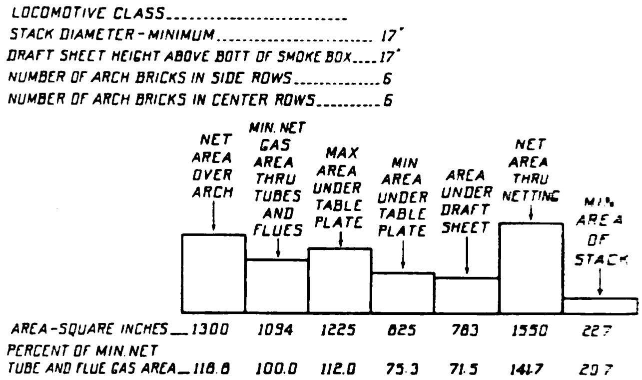


Fig. 3—Actual gas areas, U.S.R.A. Mikado locomotive

been more successful when dampers have been removed. All accompanying diagrams have been prepared on that basis.

Space Between Diaphragm Plate and Back of Stack.—The space in back of the stack may also be excessive, although this is not as likely to be responsible for poor steaming as excessive space behind the diaphragm. On smaller power, however, if the diaphragm is more than 12 in. behind the back side of the stack some improvement may be noted if an additional diaphragm plate is applied as close to the stack as possible. The compartment thus formed should be made air tight. See Fig. 7.

Space Between Front Edge of Draft Sheet and Smokebox Front.—The space between the front edge of the draft sheet and the smokebox front is very important, and in no case should the area between the draft sheet and the smokebox front be less than the area under the draft sheet. It is preferred to have the table plate extend forward from the center of the exhaust stand as little as possible, providing only sufficient plate to attach the smokebox netting and the draft sheet.

Space Below Table Plate.—Too much attention can-

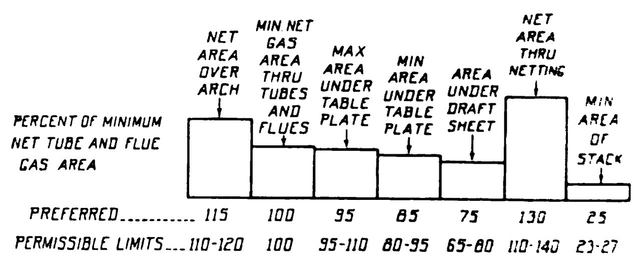


Fig. 4—Recommended gas areas

not be given to keeping the space below the table plate free from any obstructions which may hinder the free flow of gases from the firebox. The presence of large pipes, such as the booster exhaust or pipes connecting the exhaust stand or exhaust passages of the cylinder to the feedwater heater, particularly when located on the floor of the smokebox, are bound to set up eddies in the flow of gases and may be responsible for undesirable fire conditions and poor steaming. The injurious effects of these pipes may exist even though the net area under the table plate, deducting the areas of the pipes, may be well within the recommended limits. Every attempt should be made to remove these pipes from the smokebox entirely. If it is impractical to do this, the pipes should be applied directly under and close to the table plate or placed in line with the exhaust stand in order to offer as little resistance as possible to the gas flow. In some cases the main steam-pipe casings within the smokebox are unnecessarily large, making it difficult

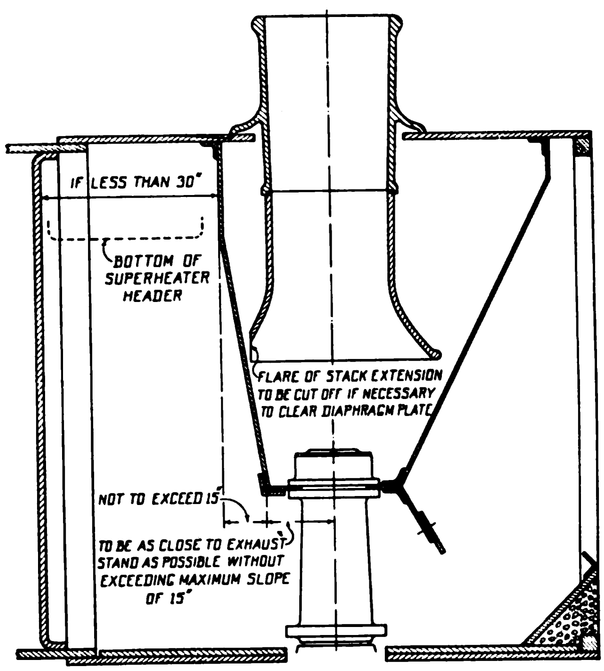


Fig. 5—Sloped diaphragm plate should be used when diaphragm is less than 30 in. ahead of flue sheet

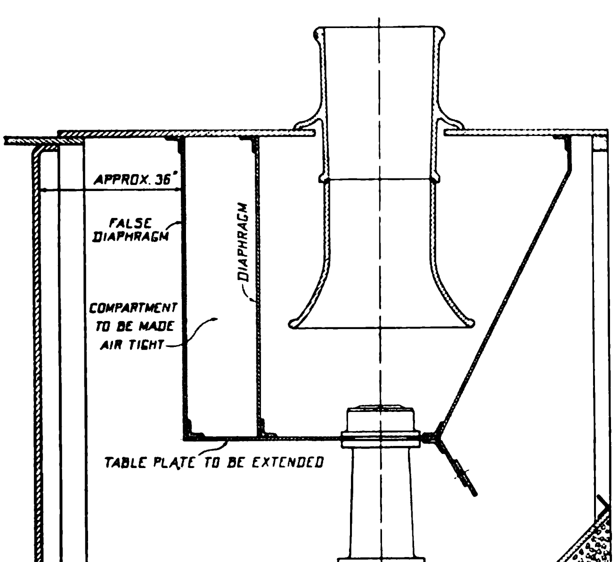


Fig. 6—Application of false diaphragm to reduce excessive smokebox volume behind diaphragm

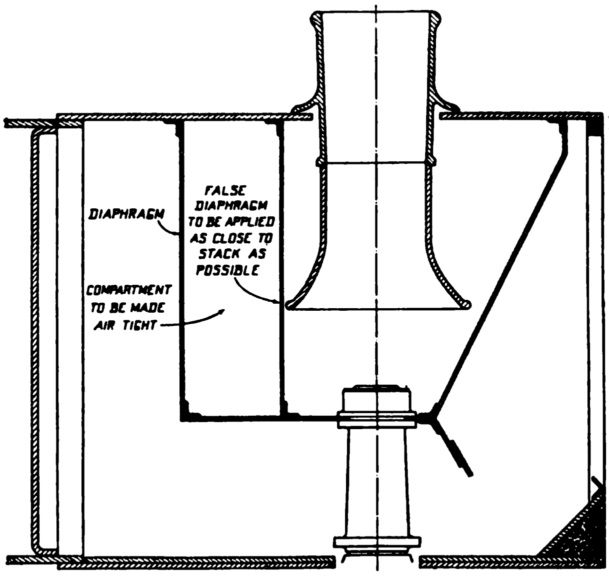


Fig. 7—Application of false diaphragm to reduce excessive smokebox volume between stack and diaphragm

to obtain the recommended minimum area under the table plate. Extra large steam-pipe casings may also have an undesirable effect on the fire by creating eddies in the flow of gases from the firebox. When these conditions exist it is recommended that the size of the steam-pipe casings be reduced in order to secure the desired minimum area rather than raising the table plate. In no case should the minimum area under the table plate be less than the minimum recommended on Fig. 1.

Design of Brick Arch

The importance of the brick arch construction is emphasized since it plays a most important part in the combustion process. The net area over the arch at the rear end should be within the limits recommended in Chart 2 in order to provide ample space for the passage of the gases of combustion and yet confine the stack loss to a minimum. Care should be taken to see that the arch is free from holes. For best results the arch should be sealed at the throat sheet. The use of "Toe" brick at the throat sheet is usually accompanied by and accountable for excessive stack loss, smoke and unequal draft distribution.

Recommended Design of Smokebox Details

Smokestack

The diameter of the smokestack will be obtained from Fig. 4 using that dimension which, in even inches, provides an area closest to that recommended. This should be the minimum diameter at the choke.

A two-piece smokestack, consisting of the stack proper and stack extension, is recommended. The stack proper should have a tapered bore throughout its length, the taper being 1 in. in diameter in 15 in. of length. While this taper is preferred, satisfactory results may be obtained with stacks having a taper of 1 in. in diameter in 12 in. of length. It is recommended that the stack taper be kept within these limits, namely 1 in. in diameter in 12 in. to 15 in. of length. Where the design permits, it is recommended that the entire length of the stack proper be made 30 in.

The stack extension should have a parallel bore equal to the minimum bore of the stack and end in a flare 28 in. to 32 in. in diameter, depending on the size of the stack. The flare should be approximately 15 in. in length and designed with a long sweeping curved surface.

The length of the stack extension will be determined by other conditions and should be such as to provide a space 15 in. to 16 in. in height between the top of the exhaust nozzle and the bottom of the stack extension. Fig. 8 illustrates the recommended design of stack and stack extension.

Exhaust Stand

The recommended design of exhaust stand is illustrated in Fig. 9. It will be noted that no provision is made for expansion of the exhaust steam within the exhaust stand as has been done in some designs. The barrel of the exhaust stand should taper directly from the rectangular shape at the bottom to the cylindrical at the top. The parting rib in the bottom of the stand

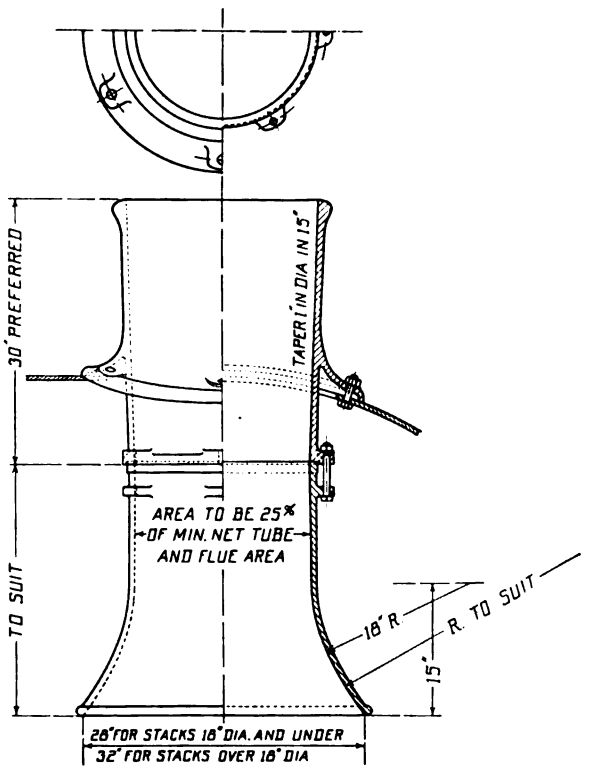


Fig. 8—Smokestack and extension

should be 8 in. to 9 in. in height. The design illustrated is applicable only to two-cylinder locomotives.

Attention is directed to the note on Fig. 9 stating that the bore of the exhaust stand at the top should never be less than ½ in. greater than the bore of the maximum diameter exhaust nozzle used.

In some cases the supply of exhaust steam for the feedwater heater is taken from the exhaust stand. This practice is not recommended as it affords an additional source of steam leaks within the smokebox. Furthermore, the pipes for conveying exhaust steam to the heater, when applied below the table plate, often offer serious restriction to the free flow of gases. It is much preferred that these pipes be connected to the exhaust passages of the cylinders and connected with the feedwater heater either entirely outside of the smokebox or in depressions built into and sealed from the smokebox.

Exhaust Nozzle

Experiments have been in progress for years to develop the "perfect" exhaust nozzle. As a result there are several nozzles of radically different design in use. The most recent experiments were those conducted at the University of Illinois by Professor Young. In his tests practically all designs of exhaust nozzles now in use were tried and the efficiency of each determined by

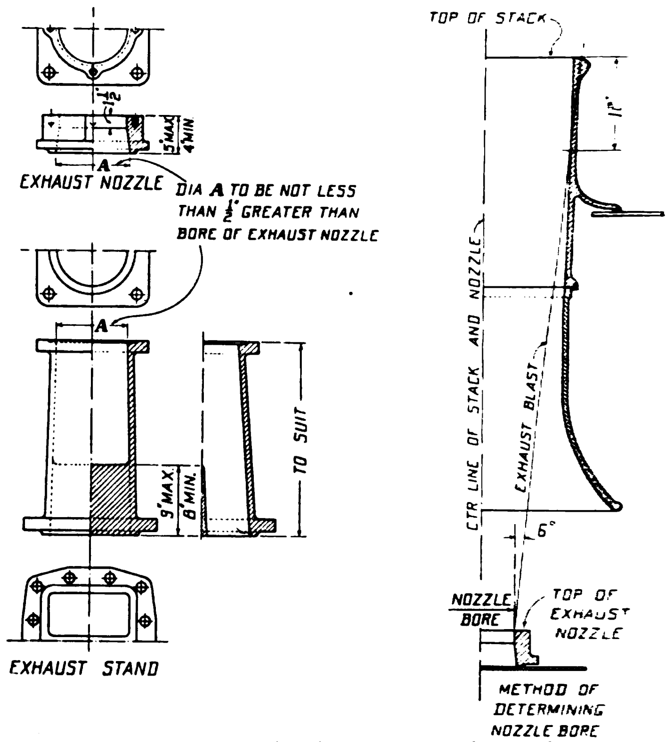


Fig. 9—Exhaust stand, exhaust nozzle and method of determining the nozzle bore

its ability to provide a steam jet which would entrain the greatest volume of air. It was determined by Professor Young that the ordinary round bore nozzle, when provided with some sort of a spreader or bridge to roughen the steam jet, is, for all practical purposes, the equal of any other type.

Because of its simplicity of construction and widespread use, as well as its proved efficiency, the round-bore exhaust nozzle is recommended. Fig. 9 illustrates the recommended design. No provision for the blower is made in the nozzle. The bore should be parallel for approximately 1½ in., and the total height, 4 in. to 5 in. The bore of the nozzle at the junction with the exhaust stand should never be less than ½ in. greater than the bore of the largest diameter exhaust nozzle used.

In determining the correct bore of the exhaust nozzle the theoretical shape of the exhaust steam blast and the point on the stack bore at which it is desired to have the exhaust blast make its "seal" must be taken into consideration. It has been found by tests with round-bore exhaust nozzles equipped with square-bar cross spreaders that the exhaust steam leaves the nozzle at an angle of approximately 6 deg. when exhausted at normal working back pressures of 8 to 10 lb. It has also been observed that best results are obtained when the theoretical "seal" of the exhaust steam jet with the bore of the stack is at a point approximately 12 in. below the top of the stack.

From the foregoing the bore of the exhaust nozzle is determined as follows and as illustrated diagrammatically in Fig. 9. Make a layout showing the inside surface of the stack. In its correct relation to the top of the stack draw a line representing the top of the exhaust nozzle. From a line parallel to the top of the stack and intersecting the stack bore at a distance of 12 in. from the top of the stack project two lines, each at an angle of 6 deg. from the vertical, to intersect the line representing the top of the exhaust nozzle. The distance between these lines, measured on the top of the nozzle, will be the recommended bore of the nozzle. For practical reasons the nozzle should be bored to the nearest even dimension in quarter inches.

When making changes in the bore of the exhaust nozzle to improve steaming qualities, it is suggested that increases or decreases in the bore be made in increments of ¼ in. with nozzles of 8 in. bore and over. For nozzles under 8 in. bore the changes should be made in increments of ⅛ in.

Exhaust Nozzle Spreader

In the course of the tests made while redrafting locomotives various types of exhaust-nozzle spreaders or bridges were tried. These included the square-bar cross spreader, the basket bridge, the single-bar spreader, and the Goodfellow prongs. Tests were also made with an open nozzle, but without notable success except on yard engines in comparatively light service.

By far the most satisfactory results were obtained with the square-bar cross spreader, and this type is recommended. In making the square-bar spreader the diagonals of the cross section of the bar are perpendicular and horizontal. The recommended design is shown in Fig. 10.

The size of the bar to be used for the spreader depends largely on the size of the nozzle, although there is no fixed rule on this. Based on the nozzle bore, the suggested sizes of the bar for cross spreader are as follows:

Nozzle Bore	Size of square bar for cross spreader
5 in. to 6⅞ in.	⅜ in.
7 in. to 7⅞ in.	7/16 in.
8 in. to 8⅞ in.	½ in.
9 in. and above	⅝ in.

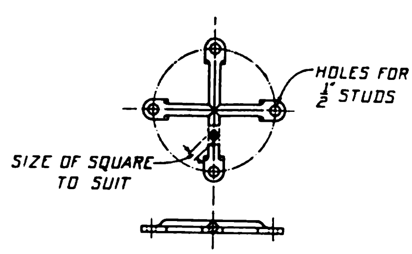


Fig. 10—Cross spreader

Where satisfactory steaming qualities and fire conditions can be obtained by so doing, it is recommended that the cross spreader rest on top of the nozzle. However, in the course of drafting certain locomotives it may be found that improvement in the fire conditions can be made by setting the bottom edge of the cross spreader ⅛ in. or ¼ in. below and into the top of the nozzle. Likewise, in some cases it may be found that a change in the size of the bar in the spreader will prove of benefit.

Blower

In many instances too little attention has been given to the blower design, although the blower is used innumerable times and for indefinite periods during each day's service of the ordinary locomotive. An inefficient blower is wasteful of fuel as well as being unsatisfactory as a draft producing device.

Because of its effectiveness in filling the stack and creating draft, and because of simplicity of construction, the "ring" type blower, made of ordinary 1¼-in. pipe, is recommended. Fig. 11 illustrates the details of the design and the recommended application of the blower.

Design and Application of Draft Sheet

The draft sheet should be securely bolted to an angle or plate attached to the front end of the table plate and should fit neatly against the sides of the smokebox. While it is recommended that this sheet be applied at an angle of 30 deg. from the vertical, better results are

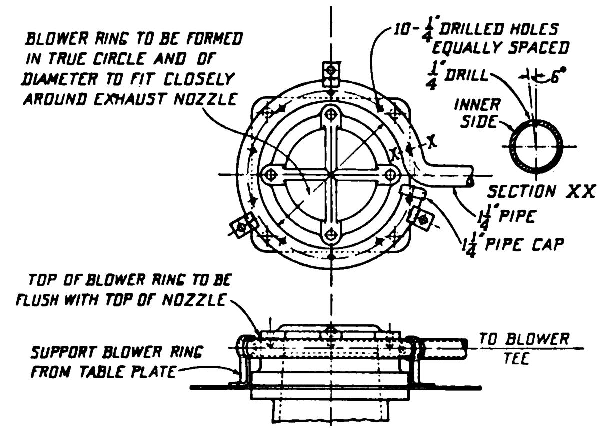


Fig. 11—Blower design and application

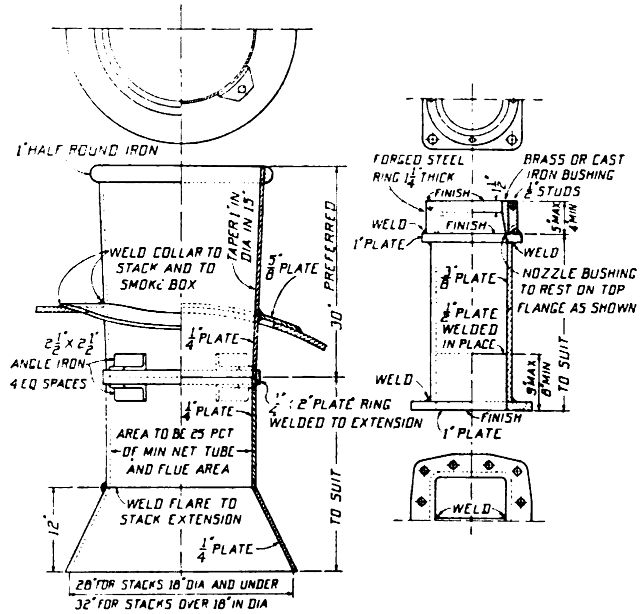


Fig. 12—Plate smokestack and exhaust stand for experimental purposes

secured in some cases when it is set at a greater or lesser angle than 30 deg. The bottom edge of the draft sheet should be perfectly straight and perpendicular to the vertical center line of the boiler. A typical application is illustrated on Fig. 1.

Deflecting Plate in Bottom of Smokebox

A deflecting plate applied at an angle of 45 deg. in the bottom of the smokebox, as illustrated in Fig. 1, is recommended because of its protective value to the smokebox front and because it serves to prevent cinder accumulation at this point. Application of an angle iron across the top edge of this plate as shown has successfully reduced cinder cutting of the smokebox door, door flange and bolts.

Construction of Stack, Exhaust Stand and Nozzle for Test Purposes

In order to provide the details necessary to redraft a locomotive for test purposes without the necessity of having patterns constructed and castings purchased, a smokestack and exhaust stand constructed of steel plate may be utilized. Satisfactory results have been obtained in this manner. A typical plate stack and exhaust stand are illustrated in Fig. 12. It will be observed that a removable bushing, held in place by the cross spreader, is used for the exhaust nozzle. This makes it possible to determine the final nozzle size to be used at a minimum of cost for labor and material.

Assembly of Smokebox Details

Typical Recommended Arrangement.—Fig. 1 illustrates a smokebox and Fig. 2 an arch brick arrangement prepared in accordance with the recommendations outlined. For convenient reference the recommended gas areas are also shown, together with other pertinent data mentioned elsewhere in this discussion.

Points to Be Observed in Assembly of Smokebox Details.—Too much care cannot be taken in assembling the various smokebox details if the utmost efficiency is to be realized. It is essential that there be perfect alignment of the stack and exhaust nozzle. All plates should be applied exactly in accordance with the drawings. The diaphragm plate, table plate and draft sheet should be tight and free from holes.

Test for Steam Leaks.—After applying the exhaust stand a hydrostatic test should be applied. The joints between exhaust stand and cylinder, and between exhaust nozzle and stand should be made perfectly tight during this test. Superheater units should be observed for leaks and tightened if necessary. All pipe joints in the smokebox must be made absolutely tight. Steam leaks in the smokebox can offset the most capable efforts to make a locomotive steam properly and lead to incorrect analyses of the fire conditions.

Test for Air Leaks.—Air leaks are responsible for much of the difficulty encountered in obtaining and maintaining good steaming qualities and economical fuel performance.

A simple test for disclosing air leaks in the front end is known as the "smoke" test and is conducted as follows: Place a cover over the entire top of the stack and then throw a quantity of coal on the fire. All air leaks of consequence will be indicated by the escaping smoke.

Discussion of the Drafts

While it is not necessary to know and record the actual drafts obtained in the combustion area and smokebox in order satisfactorily to draft or redraft a locomotive, this information forms a valuable record, especially where an extensive program of redrafting is undertaken.

Due to difficulty of securing accurate readings of firebox and ashpan drafts on the road, these drafts are given no further consideration in this discussion. If it is desired to obtain a record of these drafts it is recommended that standing tests be made.

Smokebox drafts can be obtained readily in road service and furnish all the data necessary for comparing the effects on the drafts brought about by redrafting. Smokebox drafts of most significance are those taken at the following locations: Above and below the table plate at a point just back of the junction between the smokebox netting and the table plate, and back of the diaphragm at a point approximately on the horizontal center line of the smokebox. Draft-gage pipes applied at the above positions should extend in to the vertical center line of the smokebox with the inner end of each pipe capped and provided with six staggered ⅛-in. drilled holes within a space of 4 in. from the capped end. The draft-gage pipes may be extended to a draft-gage panel in the cab thus providing safe, convenient reading of the drafts. One-quarter inch pipe is satisfactory for this purpose.

Plotting of Draft Curves

Draft readings should be plotted as illustrated in Fig. 13, plotting draft in inches of water against back pressure in pounds. It has been found helpful when plotting comparative draft curves to illustrate the effect of various smokebox changes to plot the draft at only one position in the smokebox on one sheet. A composite draft sheet such as shown in Fig. 13, illustrating the drafts at all three positions in the smokebox, should be prepared for record after changes to develop satisfactory steaming qualities and fire conditions have been completed. Draft curves for the original smokebox arrangement should be plotted in order to determine and compare the exact effect of the modified smokebox arrangement on the drafts.

Analysis of the Draft Curves

It will be noted that the draft curves illustrated in Fig. 13 are straight lines with practically the same "falling off" in the drafts from the draft above the table plate to the draft in back of the diaphragm. While the latter condition is ideal it cannot always be obtained due to limitations of design and impossibility of obtaining the preferred proportional gas areas. It should be possible, however, to obtain draft curves represented by straight lines from any locomotive which is properly drafted. Draft curves which fall off in the upper back pressure ranges indicate improper seal of the exhaust blast in the stack. This may account for smoke or other undesirable fire conditions when working the locomotive at its maximum output.

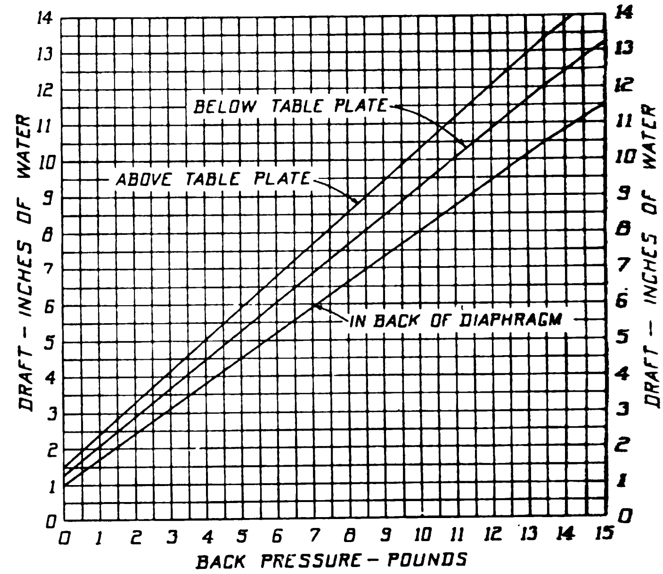


Fig. 13—A typical draft curve

A brief explanation of the draft curves plotted in Fig. 13 is offered at this point. It will be observed on these curves that some draft is indicated at zero pounds of back pressure. This condition will be found to exist in all cases where locomotives are redrafted in accordance with these principles. Due to increase in nozzle bore, back pressure will not be indicated on the gage until the steam chest pressure is from 25 to 50 lb. or higher, depending on nozzle bore. This is probably due to the lack of sensitiveness of the ordinary back-pressure gage. Draft is indicated on the draft gages, however, whenever steam is exhausted from the cylinders, regardless of the amount of steam chest pressure. The drafts illustrated in Fig. 13 at zero pounds back pressure were taken at the point back pressure was about to register on the gage.

Necessary Amount of Draft

While no attempt should be made to state definitely how much draft is necessary to produce satisfactory steaming qualities, with good fire and stack conditions, it has been observed on a large number of locomotives, redrafted in accordance with these principles, that the

best performance has been obtained when the draft in back of the diaphragm in inches of water is approximately eight-tenths of the back pressure in pounds in the normal working range of the locomotive, considered at eight to ten pounds back pressure. This figure is not empirical and is offered for its possible value as a guide.

In summary it is considered advisable to state that each class of locomotives should have only sufficient draft to burn the fire satisfactorily under all operating conditions with free steaming qualities and without smoke. Excessive drafts are to be avoided as they are largely responsible for excessive stack loss and cinder cutting of staybolts, flue sheets and various smokebox details.

Locomotive and Fuel Performance Tests to Determine Advantages Due to Redrafting

Standing Tests

Extensive use of the standing test was resorted to during early experiments in redrafting and assembling the data upon which this practice is based. The standing tests made it possible to make quickly the changes needed to produce satisfactory steaming qualities and provided information of inestimable value in arriving at the proportions recommended.

These proportions and principles of front end design have proved so reliable that a great number of locomotives, redrafted in accordance with them, have been placed in revenue service without preliminary trial. Only minor changes have been required to produce altogether satisfactory steaming qualities and stack conditions. These changes have been made without loss of time to the locomotive in any instance. It is also worthy of note that in no case has a steam failure occurred while redrafting a locomotive. In view of this, standing tests for the purpose of redrafting are not considered necessary and are not recommended.

Dynamometer Car Tests

Where a dynamometer car is available, accurate information on the improvement made in a locomotive by redrafting may be obtained by making a series of comparative tests before and after redrafting. In making such tests a division should be chosen which will provide the most consistent operation from the standpoint of tonnage and speed, and with a minimum of drifting distance. In many cases it is preferable to make the tests over only that portion of a division providing the desired conditions, thus eliminating many variables which affect the locomotive performance. It is always preferable to make the tests with the standard or original smokebox arrangement first, making sufficient tests to obtain accurate average results.

Tests with the redrafted engine to secure comparative data should not be started until it is reasonably certain that steaming qualities and stack conditions are the best that can be obtained.

On all such tests made with the dynamometer car coal should be weighed and water measured. The locomotive should be equipped with a back-pressure gage, steam-chest-pressure gage, steam pyrometer and draft gages. The reverse gear should be calibrated. Gage readings may be taken at mileposts or at specified intervals of time. The usual dynamometer data should also be recorded. All this information is essential to determine the actual benefits of redrafting and affords data for permanent record and study.

In making comparative fuel performance tests it is essential that the locomotive be worked at the same capacity on all the tests. Maintaining an equal average drawbar horsepower on tests with the locomotive before and after redrafting assures results which can safely be compared, providing this equal drawbar horsepower is obtained with fairly equal average speeds in each case. The coal per drawbar horsepower hour should be used to measure the locomotive fuel performance.

Dynamometer tests may also be conducted to determine the comparative ability of the original and redrafted locomotive to handle trains. In such tests the increased tonnage hauled by the redrafted locomotive or the reduction in running time over the division with equal tonnage will afford comparative data. On tests of this nature in which the average drawbar horsepower of the redrafted locomotive will be higher than that of the locomotive before redrafting, it may also happen that the coal per drawbar horsepower hour of the redrafted locomotive will equal or even exceed that for the locomotive before redrafting. This will be governed largely by the actual improvement in fire conditions and the amount of reduction in back pressure brought about by redrafting and the amount of increase in speed or tonnage, or a combination of both, of the redrafted over the original locomotive.

Road Tests Without Dynamometer Car (Observation Tests)

Road tests to determine comparative fuel performance of a redrafted locomotive, when made without a dynamometer car and where coal per 1,000 gross ton miles is used as a basis for comparison, are of no particular value, and may often be misleading, even though the coal may be weighed on such tests. While tonnage and average speed may be kept comparable there are other uncontrollable factors entering in, which may affect coal consumption and the locomotive performance generally.

Increase in tonnage or speed for the redrafted locomotive may be determined without the use of a dynamometer car. Tests or trial runs for this purpose should certainly be made in order that the advantages, brought about by redrafting, may be utilized. Whenever tests are conducted without a dynamometer car it is recommended that cab gage readings, including the draft readings and cutoff, be taken as on dynamometer tests. The data secured will prove of considerable value.

Although in some cases immediate improvements in the fuel and general performance of a locomotive may be obtained by making partial changes in line with these recommendations, the greatest success from an application of the foregoing principles of drafting can be realized only when the procedure indicated is carried out in its entirety as outlined.

The subcommittee report was signed by D. S. Ellis (chairman), mechanical assistant to vice-president, C. & O., and A. H. Fetters, general mechanical engineer, U. P.

A Hundred Years Ago—The following is an excerpt from a letter written on July 22, 1835:

This morning at 9 o'clock I took passage in a railroad car from Boston, Mass., to Providence, R. I. Five or six other cars were attached to the locomotive, and uglier boxes I do not wish to travel in. They were made to stow away some 30 human beings who sit cheek by jowl as best they can. By and by just 12—only 12—bouncing factory girls were introduced who were going to a party of pleasure to Newport. "Make room for the ladies!" bawled out the superintendent. "Come, gentlemen, jump up on the top, plenty of room up there." The rich and the poor, the educated and the ignorant, the polite and the vulgar, all herd together in this modern improvement in traveling, master and servant, sit in each other's laps, as it were, in these cars, and all this for the sake of doing very uncomfortably in two days what would be done delightfully in 8 or 10.

Cross or Simple

COUNTERBALANCING

By Kenneth F. McCall

An investigation to determine comparative dynamic augment with simple balancing and crossbalancing

SEVERAL papers and articles on the subject of counterbalancing have appeared in the last few years. Practically all have agreed that the crossbalancing of the main wheels results in a considerable reduction of the dynamic augment and a much better riding locomotive.

The following is an investigation to compare the dynamic augment of the main driving wheels of a locomotive when the revolving weights are crossbalanced with the dynamic augment of the same wheels when the revolving weights are simple balanced. In this discussion all weights mentioned are in pounds.

The locomotive chosen for consideration has the following characteristics:

Type	4-6-2
Cylinders, diameter and stroke	22 in. by 28 in.
Driving wheels, diameter	73 in.
Weight on driving wheels	53,000 lb.
Total weight of locomotive in working order	240,000 lb.
Steam pressure	200 lb. per sq. in.

In this discussion the following designating terms are employed for the weights considered:

W = Weight of the locomotive.
W_1 = Total weight of reciprocating parts.
X = Total weight of main rod.
X_1 = Weight of main rod considered as revolving.
X_2 = Weight of main rod considered a reciprocating.
X_3 = Weight of back end of main rod.
Y_1 = Weight of side rods on main pin (four coupled).
Y_2 = Weight of side rods on intermediate pin (four coupled).
P, Q, N, M, — Scale weights of side rods at points indicated in Fig. 2.
Y_3 = Weight of side rods on main pin (three coupled).
Z_1 = Weight of large end of eccentric crank with included part of crank pin.
Z_2 = Weight of small end of eccentric crank plus portion of eccentric rod considered as revolving.
Z_3 = Equivalent weight of Z_2, at point O (Fig. 1).
Z_4 = Equivalent weight at large end of eccentric crank when Z_3 is considered as Z_5.
Z_5 = Equivalent weight at crank pin radius of Z_3.

Eccentric Crank—For proper counterbalancing, the weight of the small end of the eccentric crank must be considered in its proper relation to the other revolving parts. A method for making this consideration (see Fig. 1) follows:

$$Z_3 = \frac{Z_2 A}{A + B} \quad \text{.......... (1)}$$

$$Z_5 = \frac{Z_2 AD}{(A + B) C} \quad \text{.......... (2)}$$

$$Z_4 = Z_1 + \frac{Z_2 B}{A + B} \quad \text{.......... (3)}$$

Main Rod—That portion of the weight of the main rod to be balanced as revolving weight is found by the formula:

$$X_1 = \frac{X r^2}{l^2} \quad \text{.......... (4)}$$

where r = radius of gyration of the main rod about the wrist pin in inches.
l = length of main rod from center to center in inches.

The remaining weight to be considered as reciprocating weight is:

$$X_2 = X - X_1 \quad \text{.......... (5)}$$

The radius of gyration of the main rod can be found either experimentally or by computation. If the former method is chosen the main rod should be swung as a pendulum about its wrist pin center, and its time of oscillation noted. Then the radius of gyration can be found by the formula:

$$r = \sqrt{3.26\ t^2 a} \quad \text{.......... (6)}$$

where r = radius of gyration in inches
t = time of one swing, in second.
a = distance from wrist pin center to center of gravity of main rod.

A fairly close approximation for the revolving weight of the main rod can be made by the following formula:

$$X_1 = 0.875\ X_3 \quad \text{.......... (7)}$$

That portion of the eccentric rod weight to be considered as revolving with the small end of the eccentric crank may be determined by the same methods that gave formulas 4 and 6.

Reciprocating Weights—The percentage of reciprocating weights to be balanced may be found by the formula:

$$\text{Per cent to be balanced} = \frac{16s\,W_1 - W}{16s\,W_1} \quad \text{.......... (8)}$$

where s = piston stroke in inches,
W_1 = total weight of the reciprocating parts, including X_2 in Formula 5.

Side Rods—The weight on each crank pin due to the side rods is determined by treating each side rod separately as shown in Fig. 2 which shows the side rods for a four-coupled locomotive. The four-coupled arrangement, however, is used for illustrative purposes only. In Fig 2, the weight on the main and intermediate pins,

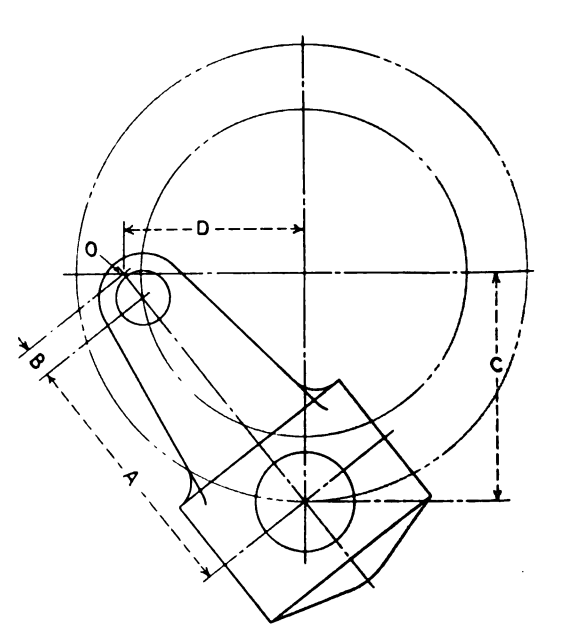


Fig. 1

respectively, due to the side rods may be found by the formulas:

$$Y_1 = Q + \frac{P(F + G)}{F} - \frac{ME}{F} \quad \text{.......... (9)}$$

$$Y_2 = N + \frac{M(F + E)}{F} - \frac{PG}{F} \quad \text{.......... (10)}$$

where weights and distances are as shown in Fig. 2.

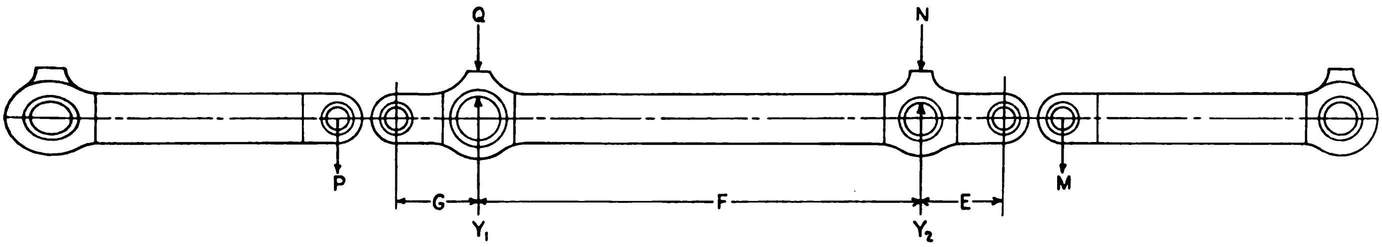


Fig. 2

For the locomotive under discussion, a 4-6-2 type, the formula for the weight of the side rods on the main pin would be:

$$Y_2 = Q + \frac{P(F+G)}{F} \qquad (11)$$

Dynamic Augment—The dynamic augment should be considered as acting in the vertical plane passing through the point of contact between the wheel and rail, herein called the "plane of the rail," and not in the plane of the counterbalance.

The vertical component of the main rod due to the steam pressure should be added algebraically to the dynamic augment after due allowance has been made for transferring this component into the plane of the rail, and the force necessary to accelerate and decelerate the reciprocating parts has been subtracted.

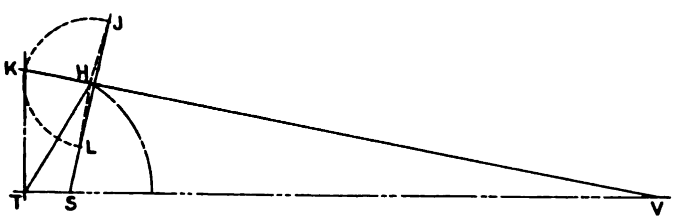


Fig. 3

A method for finding this acceleration is shown in Fig 3, where

TK = the vertical center line of the wheel.
TV = the center line through the wheel and cylinder neglecting the difference in height between the two.
TH = $\omega^2 R$
ω = the angular velocity of the crank pin in radians per second.
R = the crank-pin radius in feet, to be laid off at any desired crank angle.

$$HV = \frac{(L)}{(R)}\omega^2 R$$

$\frac{L}{R}$ = the ratio of the main rod length to the crank radius.
HK = HV extended to intersect TK at K.
LKJ = an arc swung about H as a center.
LHJ = an arc swung about V as a center.
JLS = a straight line drawn through the intersections of arcs LKJ and LHJ and extended to intersect TV at S.
Then TS = the acceleration in feet per second of the reciprocating parts for that particular crank angle.

This was done for every 15 deg. of the crank angle through one complete revolution of the wheel, the speed of the locomotive being taken as "diameter speed," or 73 m.p.h.

The total piston pressures were computed for every 15 deg. from indicator cards resolved into stroke cards. Allowance was made for the area occupied by the piston rod on the back side of the piston, and for back pressures on opposite sides of the piston.

The forces necessary to cause the acceleration found by the method described for each crank angle were subtracted algebraically from the corresponding piston pressures. The remaining piston pressures were resolved into vertical components acting at the crank pin, their values depending on the angle of the main rod. This component was added algebraically to the dynamic augment after it had been transferred into the plane of the rail.

Graphs—The dotted line on Fig. 4 represents the vertical forces working in the plane of the rail on the right wheel caused by the left main rod. The broken line represents the vertical forces working in the plane of the rail on the right wheel caused by the right main rod. The full line is the sum of these two vertical forces.

The procedure for computing the 90-deg. weight to go in each wheel when crossbalancing, and finding the angle to offset the counterbalance, has been written up so many times that it is not deemed necessary to give it again.

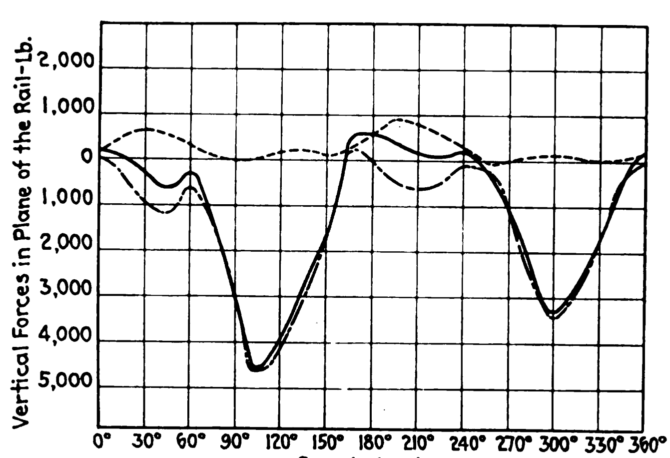


Fig. 4

The following table gives the necessary data to work this out:

Weight of side rods, including the encircled part of the crank pin	523.3 lb., by Eq. 11
Weight of main rod, including the encircled part of the crank pin	471.8 lb., by Eq. 7
Weight of large end of eccentric crank, including the encircled part of the crank pin	95.1 lb., by Eq. 3
Weight of small end of eccentric crank, including that part of the eccentric rod considered as rotating	61.8 lb., by Eq. 2
Equivalent weight of crank pin hub	287.0 lb
Distance between:	
Planes of the rail	59.00 in.
Crank-pin hub centers	64.00 in.
Counterbalance centers	64.00 in.
Side rod centers	75.26 in.
Main rod centers	87.00 in.
Large end of eccentric crank centers	96.20 in.
Small end of eccentric crank and part of eccentric rod considered as rotating, centers	101.00 in.

Considering the revolving parts to be completely crossbalanced there will be no dynamic augment other than that caused by the weight added in the counterbalance for the reciprocating weights. To this must be added the vertical component of the main rod.

The weight added for the reciprocating parts was placed opposite the crank pin and was determined by Equation 8. The percentage to be balanced was 59 per cent and was split up equally among all six driving wheels.

The weight added for the reciprocating parts was transferred into the plane of the rail and then the dy-

namic augment at diameter speed computed for a complete revolution at 15-deg. intervals. To this was added algebraically the corresponding vertical components of the main rods. The sums of the dynamic augments and the vertical components for each 15-deg. interval were plotted, resulting in Curve B, Fig. 5, for the right-hand side, and Curve D, Fig. 6, for the left hand side. In both graphs the crank angles given start with the right-hand crank pin on forward dead center, and consider the wheel to be rolled forward. That is, the left crank is considered to start at 270 deg.

When the wheels are simple balanced the counterbalance weight at crank-pin radius is the sum of the rotating weights and one-sixth of the percentage of the reciprocating weights to be balanced. The procedure is the same as before except that the 90-deg. weight to go in the opposite wheel is not put in. On this locomotive the result of the simple balancing is shown in the following table:

	Right Wheel	Left Wheel
180 deg. Overbalance	122.3 lb.	78.4 lb.
90 deg. Underbalance	240.7 lb.	73.2 lb.
Resultant weight	270.0 lb.	107.2 lb.
Resultant angle with the horizontal in the second-quarter	63 deg. 4 min.	47 deg. 0 min.

The weights and resultants in the above table work in the plane of the rail. The vertical components of the resultants were computed for every 15 deg. of the crank angle as in the cross balanced method and their centrifugal forces computed. To this was added the main rod effect as before.

These intervals were plotted, resulting in Curve A, Fig. 5, for the right side, and Curve C, Fig. 6, for the left side.

An inspection of the curves shows that there is little to be gained by crossbalancing the main wheels of this locomotive as far as the right side is concerned, while on the left side crossbalancing is at a distinct disadvantage compared to simple balancing.

The following is a table comparing the maximum resultant vertical components (dynamic augment plus main-rod effect) for the two systems of balancing:

	Maximum Vert. Comps.		Angle of Right Crank	
	Right side	Left side	Right side	Left side
Crossbalanced	13,900 lb.	13,900 lb.	285 deg.	75 deg.
Simple balanced	14,250 lb.	4,960 lb.	315 deg.	15 deg.

It is apparent from previous papers on counterbalancing that the sum of the static load and the dynamic augment has been considered as the stressing load on the rail. In a discussion of Lawford H. Fry's "Locomotive Counterbalancing," printed in the June, 1934, "Transactions of the A.S.M.E.," A Giesl-Gieslingen expresses the opinion that a dynamic augment of 15 to 20 per cent of the static wheel load will stress the rail only slightly higher.

The theory that the magnitude of the dynamic augment is not a direct measure of the increase or decrease in rail stress seems reasonable when it is considered that the rails and ties act as a vibrating beam. The true increase or decrease in rail stress would be in increase or decrease of pressure between wheel and rail caused by the resultant vertical force in the wheel to or from the rail. This would represent the true dynamic augment. However, for the sake of convention, the author of this paper has given the term "dynamic augment" its usual interpretation, with the exception noted in the paragraph immediately following Equation 11.

The dynamic action of reciprocating and out-of-plane revolving masses encountered in locomotive machinery produces several undesirable effects which must be absorbed by the locomotive, the train, and the right of way. These effects are: Vertical oscillation, longitudinal oscillation, lateral oscillation, rolling, nosing, and galloping.

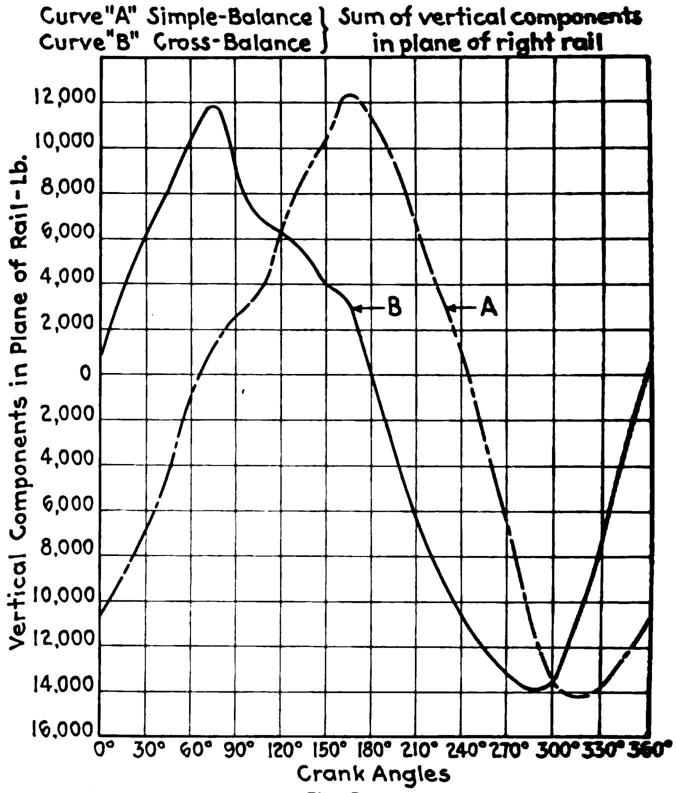


Fig. 5

Vertical oscillation and rolling are partially due to the dynamic augment. It is imperative to distinguish clearly the difference between dynamic augment, longitudinal oscillation, and nosing, because any attempt to improve one condition would be done at the expense of one or both of the others.

The dynamic augment is not the whole cause of variation in rail load, because of the vertical component produced in the main rod from the thrust and pull of the piston pressures and the inertia of the reciprocating

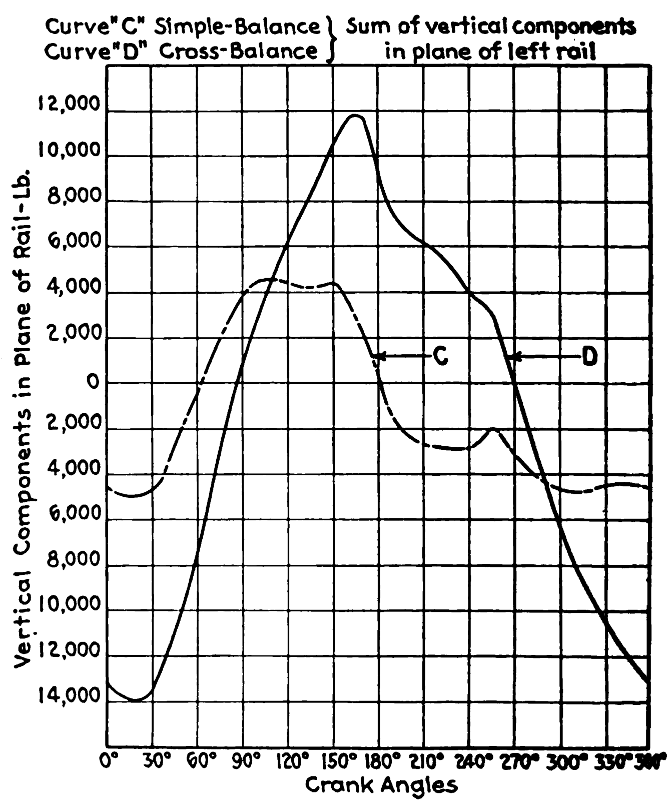


Fig. 6

parts. The angularity of the main rod causes the acceleration of the reciprocating parts to vary throughout the stroke. The piston pressures will also vary due to cutoff, expansion and other thermodynamic changes that normally take place in the cylinders. These two factors make it impossible to balance and thus reduce that portion of the variation in rail load, although they should be taken into account when the total resultant vertical force of the rotating parts is being computed.

Undoubtedly it would be desirable to balance for the valve gear, but owing to the complicated motions and the variations in cutoff it would be impossible. However, no counterbalancing could be called accurate unless a portion of the eccentric rod was considered.

Crossbalancing of the main wheels would reduce the dynamic augment in them to zero if it were not for the vertical component in the main rod and the weight added to the balance for the reciprocating parts. Too great a reduction in the percentage of reciprocating parts balanced will increase the longitudinal oscillation. If this reduction is carried too far these oscillations will be felt quite plainly in the forward part of the train, causing discomfort to the passengers. A decrease in percentage of reciprocating parts balanced means a decrease in dynamic augment and an increase in the longitudinal oscillations.

It has been suggested that for a complete balance the weight in the counterbalance for the reciprocating weights should be crossbalanced also. This would reduce the nosing, increase the dynamic augment, and make no difference in the longitudinal effect.

It has also been suggested that no reciprocating weights be balanced in the main wheels, adding extra weight in the coupled wheels to make up the deficiency, and completely crossbalancing the main wheels. While it is true this would reduce the dynamic augment in the main wheels to that caused by the vertical component in the main rod, it would increase the dynamic augment in the coupled wheels, tending to put a kink in the rail between the two coupled wheels adjacent to the main wheel. How much harm this would do the rail is a matter for further investigation.

Federal Co-ordinator's Report on

Modernization of Shops

On June 12 the Federal Co-ordinator of Transportation issued a report on the consolidation and modernization of repair shop facilities which was prepared by the Section of Property and Equipment. This report deals with the studies of the original co-ordinating committees to determine the economies in maintenance of equipment which might result from consolidation or joint use of existing major shop facilities and the study undertaken by the Section of Purchases which ascertains the economies which might reasonably be expected to result from carrying out a complete program of modernization of repair shop facilities.

Conditions Supporting Shop Situations

The report indicates that there are in existance (although not necessarily in active operation), 403 locomotive repair shops; 568 freight and passenger car shops and 3,271 enginehouses. The report points out that the present situation with respect to the large number of existing repair shops, is, in general, the result of conditions brought about by the consolidation, in some cases many years ago, of numerous small railroads, each of which had provided repair facilities which were considered suitable for the then existing individual requirements and for the accommodations of small light capacity locomotives and cars.

Excessive maintenance costs have naturally resulted from the use of shop facilities unsuited, even if new, for repairing equipment of sizes, weights and designs not contemplated in the original design of the shops and their equipment. None of the great railway systems of this or any other country were originally planned or built as such, hence the great variation in policies methods and operating practices.

It is significant to note that several of our most successful railroads, measured by low operating costs and regular dividend payments to stockholders, are those roads which have consolidated their repair operations into the least possible number of shops, and have provided modern equipment and facilities for maintenance. This policy, combined with highly efficient management, has made it possible for them to use motive power and rolling stock much more intensively than the average railroad, hence requiring a minimum investment in the equipment required to perform a given volume of satisfactory transportation service. Intensive use of equipment naturally requires a high standard of maintenance, which is fully justified by the overall performance of those railroads, and definitely points the way to lower operating costs.

The almost revolutionary changes in operating conditions since the advent of steel freight cars, and of high powered locomotives making possible the hauling of trains consisting of 100 to 150 cars and more, over long distances at high speeds, have eliminated the necessity for many intermediate yardings en route, with the result that many shops and yards are no longer geographically located in the right place to meet existing conditions. During the era of railroad expansion from 1865 to about 1900, many small new railroads were built. Quite a number of the shops built during that period are still in use, having been enlarged, and additional machinery equipment installed. It would today be a hopeless task to modernize and relocate these facilities in such a way as would enable their efficient use for repairing modern equipment to meet the requirements of present day operating conditions.

The Equipment-Maintenance Situation

Locomotive heavy repairs are by far the most complicated work connected with equipment maintenance. The layout and arrangement of repair facilities considered most economical for one type of locomotive and for certain details of design will not be the most economical for locomotives of radically different type or design. Each railroad has established a certain degree of standardization in the design and details of locomotives, to suit its individual needs, and until some general standardization is accomplished, this situation will still further complicate the problem of maintenance when

Relation of the Approximate Value of Shops and Enginehouses, and Shop Machinery to Expenditures for Improvement June 30, 1914, to December 31, 1931

Account	(1) Reproduction value as of Dec. 31, 1931	(2) Net expenditures for additions and betterments 17.5 years	(3) Average expenditure per year	(4) Cycle of time required for complete replacement (years)	(5) Indicated average (years)
(a) Shops and enginehouses (Acct. 20)	$678,706,319	$282,670,876	$16,152,620	42.018	21.009
(b) Shop machinery (Acct. 44)	320,493,901	128,610,000	7,349,100	43.600	21.800
Total	$999,200,220	$411,280,885	$23,501,720	42.516	21.258

locomotives owned by one road are sent to the shops of another for major repairs. Experience with this phase of maintenance during Federal control, (1918-1920) when some 3,000 locomotives were sent to shops other than those of the owning line, demonstrated beyond question that delays and duplication of investment in parts, due to differences in design and standards of maintenance, must be expected so long as so many different standards exist. There must be real national standardization in the matter of locomotive design, shop practices, limits of wear, and policy of renewals, before full advantage can be taken of joint use of heavy repair shops especially when those shops must be used to repair locomotives of widely different design intended to serve different transportation requirements.

Freight car repairs represent one of the largest single items in the maintenance of equipment accounts. The two million odd freight cars are freely interchanged and used by all railroads under A.A.R. Car Service Rules. Because of the many different types, sizes, and styles, they present a most difficult problem so long as they continue to be owned by 144 individual Class I Railways and maintained to different standards of physical condition. They must, however, be maintained in a safe and suitable condition for service on all roads, regardless of location with respect to repair shops of the owning roads.

Freight car maintenance averaged per year $326,599,-432 for the fifteen year period 1920-34 inclusive, $357,-550.085 for the thirteen year period 1920-32 inclusive, $407,710,936 for the ten year period 1920-29 inclusive, and $164,376,425 for the five year period 1930-34 inclusive. The difference between the two latter figures, when adjusted for the different number of cars and difference in intensity of use during the two periods, represents the degree of undermaintenance occurring between the two periods. Freight cars of modern design will run about five years from date built before requiring heavy repairs which include wheel renewals, painting etc., and will require similar treatment about every three years thereafter. About 10 to 12 years from the date built, the average freight car will require extensive renewal of body parts, this type of repairs being usually termed "rebuilding."

The advantages of a single owning agency, from the standpoint of transportation, have been presented in reports of the Co-ordinator's Section of Car Pooling. The advantages of single ownership from the standpoint of maintaining equipment are of about equal financial importance, since cars could be more fully standardized as to all parts than when individual standards are maintained by 144 Class I railroads. By locating major repair shops at strategic points adjacent to important area gateways, all major classified repairs could be made by the owning agency with a minimum of empty car movement between points of use and points of repairs and between the latter and loading areas.

The total number of passenger-train cars owned (excluding Pullman cars) was 43,845 as of December 3, 1934. Most of the work involved in repair operations on this equipment consists of manual labor, such as cleaning, painting, upholstering, and refinishing hardware and trim, and can be performed with almost equal economy in any reasonably well-equipped plant. The only work requiring overhead crane service is the lifting of cars sufficiently to remove and replace trucks and making actual repairs to the trucks and other heavy parts. Heavy repair work could be advantageously concentrated and performed in modern fireproof facilities

The Cost of Obsolete Shop Machinery

Detailed information obtained from three reputable manufacturers—(a) a machine tool builder, (b) an automobile manufacturer and (c) an electrical equipment manufacturer—shows that the average age of machine tools in these three groups is between 8 and 9 years, and of a comparatively few individual tools, more than 12 years. The combined annual machine-tool repair cost is equal to 1.2 per cent of the original cost, as compared with an average of 7.4 per cent annual repair cost for all railroad shop machinery having an average age of 21.8 years. Under a general policy of renewal of machine tools on all railroads so planned that the average age would not exceed 7½ to 8 years, with an ultimate life of 15 to 16 years, instead of 21.8 and 43.6 years respectively, it is reasonable to assume that the annual repair cost would not exceed 1.2 per cent of total investment, or $3,846,000, a reduction of $19,854,000 below the annual average of $23,700,000 expended during the 12-year period 1920 to 1931 inclusive.

It is evident from the above facts that if the average age of all railroad shop machinery were reduced from 21.5 to 7.5, or 14 years on the average, the saving in repair cost alone at $19,854,000 per year would amount to $277,956,000, or 87 per cent of an amount sufficient to replace all existing shop machinery, without considering any other advantages of the ownership and use of modern high production machine tools, including lower production costs and more accurate products.

An illustration of the inadequacy of railroad repair shops as a whole to perform repairs economically on large modern locomotives is found in the fact that the average cycle of replacement of all shops and engine houses is 42.018 years, corresponding to an average age of 21.009 years. During this length of time, the average tractive power of all steam locomotives has increased from approximately 31,250 pounds to an average of 46,400 pounds in 1932, or 48 per cent, resulting in corresponding increases in weight and size. In addition, a great many locomotives have been equipped with large capacity tenders, resulting in much difficulty and additional expense in making needed repairs, with facilities originally built to accommodate much lighter and shorter power.

Estimated Savings from Complete Modernization and Joint Use of Repair Facilities

The estimated savings that can reasonably be expected to result from a complete modernization program of repair shop buildings, facilities and machinery based

upon the actual experience of those who were in direct charge of such a program and after making due allowance for average conditions differing from the specific case studied are conservatively calculated and shown in one of the tables.

The total estimated savings will be $365,902,000 per annum. The expenditure of new money necessary to accomplish this result will be approximately $1,141,350,000 indicating a return of 32.05 per cent per annum.

Based upon the average operating revenues and expenses, for the 10-year period 1923 to 1932 inclusive, a saving of $318,319,000 in the operating expenses would have resulted in a ratio of operating expenses to operating revenue of 68.93 per cent instead of the actual ratio of 74.63 per cent. The entire amount of the total annual savings in operating expenses and fixed charges (interest, taxes and insurance) amounting to $365,902,000 will be available after 3.12 years of operation, (the period required to save the entire cost of improvements) for the payment of dividends since the amount of retirements of equipment and facilities made possible by the modernization program will exceed by a small margin the cost of the new facilities.

Particular attention is directed to the fact that in preparing the estimate of possible savings, wherever there was more than one basis on which to compute the savings, the one resulting in the smaller amount was invariably selected. No effort was made to search out the small savings such as for example the space required for the storage of the 255,698 freight cars that are in bad order at all times in excess of a reasonable amount (4 per cent) which requires the use of 1,937 miles of tracks.

The estimated savings are the combined results of management, operation and proper facilities. The amount of saving due to any particular phase cannot be determined separately with the data available.

General Conclusions

Consideration of the facts presented in this report leads to the following conclusions:

1—Railroad repair facilities, as a whole, include an unduly high proportion of obsolete buildings, machinery, and accessory equipment. The continued use of these obsolete facilities results in high costs of maintaining equipment, not only in respect to actual work performed, but also in respect to the quality of the work. This applies particularly to machine-tool work, in which the accurate dimensioning and close tolerances required for easy fitting and assembling, and minimum running repairs, cannot be secured without modern machine tools, even though older tools have been maintained in a condition as good as new. While it is obvious that railroad repair shops cannot be operated on a mass production basis such as that of automobile plants, the contrasts between the most modern and the average railroad shops, as to layout, equipment, methods, and results obtained, demonstrate clearly that modernization will pay large dividends on any reasonable investment made with proper consideration of all factors, including not only repair costs but average condition and service requirements of locomotives and cars.

2—Consolidation or joint use of existing major repair shops, without installing new machinery, will result in comparatively small savings. Somewhat larger savings could be made if new machinery were installed in the shops selected for joint use, but savings through the use of modern machinery, though important, represent only about 20 per cent of total savings estimated to be possible through complete modernization of shops together with establishment of sound policies in respect to condition of equipment and maintenance schedules. Most existing shops were designed to perform both classified repairs and running repairs, and consolidation of classified repairs would not permit abandonment of any considerable number of existing shops.

3—No general program for replacing shop machinery should be adopted until a sound and balanced plan has been worked out in respect to average condition of locomotives and cars, repair schedules required to maintain that average, and kind and location of repair facilities needed for the purpose. Such a plan will undoubtedly involve abandonment of certain existing facilities and construction of some new facilities, as well as installation of modern machinery. Neither redistribution of work among existing shops, nor installing new machinery in such shops, can accomplish maximum attainable results. Such results can be obtained only through a combination of both, made in accordance with a general plan such as that mentioned above.

4—Except for normal replacement of obsolete locomotives and cars, unsuited to modern transportation requirements and known to require unduly high maintenance, no new equipment should be purchased until the surplus of unserviceable equipment has been eliminated, and policies set up whereby the average proportion of bad-order equipment can be limited to 14 per cent for locomotives and 4 per cent for freight cars.

5—The opportunities for making substantial reductions in total operating expenses through reduced cost of maintaining equipment are too great to be disregarded. Conditions during the past five years have been such as to preclude any expenditure not immediately necessary, and in many instances railroad managements have been obliged to lower their normal standards of maintenance of all property and equipment. Much deferred maintenance will have to be made up in the near future in order to preserve railroad properties in condition to handle even the present volume of traffic to the satisfaction of their patrons. This situation presents a real opportunity for constructive long-range planning in all phases of railroad operation, by individual railroads and co-operatively through the Association of American Railroads. The establishment of proper standards for equipment operation and maintenance, and soundly planned modernization of the facilities needed to maintain such standards, should result in a degree of efficiency and economy comparable to that attained by the railroads as a whole in operating their freight and passenger trains.

Summary of Net Charges to Investment in Road and Equipment, Class I Steam Railway Companies and Their Non-operating Subsidiaries

Year	(1) Total net charges to investment in road and equipment	(2) Shops and engine-houses (primary Acct. 20)	(3) Shop machinery (primary Acct. 44)	(4) Total shops and engine-houses, and shop machinery (Col. 2 + 3)
1931	$540,727,971	$9,999,133	$4,910,212	$14,909,345
1930	590,204,981	10,082,324	5,283,268	15,365,592
1929	552,239,423	13,222,324	4,568,011	17,790,335
1928	458,998,490	7,949,799	4,033,163	11,982,962
1927	698,068,811	17,259,317	8,103,097	25,362,414
1926	652,418,776	26,207,787	11,303,873	37,511,660
1925	579,974,749	23,157,807	10,178,104	33,335,911
1924	714,251,390	22,057,022	13,018,512	35,075,534
1923	808,207,770	27,011,249	14,671,652	41,682,901
1922	362,089,974	9,318,500	6,392,015	15,710,515
1921	442,043,129	16,626,817	7,905,243	24,532,060
1920	551,459,137	14,003,255	7,466,414	21,469,669
1919	319,805,771	26,815,981	11,384,145	38,200,126
1918	466,528,437	27,644,204	7,775,692	35,419,896
6/30/14 through 12/31/17	$2,692,898,733	$31,315,357	$11,616,608	$42,931,965
Totals 17.5 years	$10,429,917,542	$282,670,876	$128,610,009	$411,280,885
Average per year	595,995,000	16,152,620	7,349,100	23,501,720
Per cent of total	100	2.71	1.23	3.94

EDITORIALS

Man-Power For the Future

The railroad shops are now running more nearly on a normal basis than they have for several years, although they are repairing only as many locomotives and cars as appear to be clearly necessary on the present basis of commerce and industrial production. The heads of the mechanical departments, carefully and critically studying every move, are attempting to anticipate the needs of the operating departments, but are making their estimates on a fairly conservative basis and are keeping only far enough ahead of the demands to insure a reasonable degree of safety.

On some railroads locomotives long out of service, but with considerable mileage still to be run, may be made available with a small amount of back-shop work to put them into serviceable condition. Incidentally, on not a few railroads, the mileage between shoppings has been so greatly extended because of more careful inspection and better engine-house maintenance that really surprising results are being obtained. This also insures a certain amount of reserve that was not available under former conditions.

But what of the human element? Many of the older skilled workers have dropped out during the depression years and will never return to railroad service. Meanwhile, few new mechanics have been made although some of the railroads have gone ahead with apprentice training on a modest scale. Concern is now being shown in many quarters over the possible shortage of skilled labor as business continues to pick up and greater demands are made for equipment. Some roads have already speeded up their apprentice training activities and the class room and shop instructors are back on the job or are giving more time to it, if they were not entirely displaced during the lean years.

In looking over two groups of apprentices recently in widely separated sections of the country, one could not but be impressed by the fact that they were made up largely of high school graduates. Questions asked by these boys indicated an ambition and keen desire to make the most of their opportunities. They are not quietly riding along with the current, but seem to be using their heads and studying the situation to determine how best to take advantage of it. Among the questions that some of them asked were these:

"I am a boiler shop apprentice. Will the use of the Diesel engine eliminate my trade? How can I protect myself?"

"What effect, if any, will competition from other common carriers have on the railways?"

"Will the railroads continue to be the backbone of the transportation system of this country?"

"Will it be wise for me to take a correspondence school course in addition to my regular apprentice training?"

"How can I train myself for work on Diesel-electric locomotives?"

"Would you advise me to try to get a college training? If so, shall I wait until my apprentice training is completed or shall I break away at the end of my first, or second, or third year of apprenticeship?"

The railway mechanical departments can help themselves by assisting these boys to "find themselves" and secure the best training for the future.

"Yes," said a shop superintendent, "I encourage boys with the right personality and ability to leave the service and go to college if they can finance themselves. I lose them, but in most cases they are favorably disposed toward the railroads and may come back to our railroad or some other railroad when they secure their degrees. Most of the boys, however, will complete their apprenticeship and remain with us. Unless I miss my guess, we will be sorely in need of trained mechanics in the not distant future. Indeed, if we add much more to our present operations, we will begin to feel the pinch for trained mechanics. Incidentally, some of these lads will also be needed within a few years for supervisory positions. Frankly, I have been trying to select some of them for apprentice training with that end in view."

What of the future?

Herbert N. Gresley Knighted

Each year on the birthday of the King high honors are conferred on men and women who have rendered outstanding services in the British Empire. On June 23 of this year, King Edward VIII, on his first birthday since his accession to the throne, announced an honors list which included Chief Mechanical Engineer Herbert Niegel Gresley of the London & North Eastern Railway as a Knight Bachelor.

The honor conferred upon Mr. Gresley will meet the approval of railroad mechanical engineers throughout the world who have followed with keen interest his efforts in the improvement of locomotive design for these many years. Americans are familiar with and proud of officers of the Canadian railways who have in the past received birthday honors, including such men as the late Sir Henry Worth Thornton, Sir George Bury and Sir Edward Wentworth Batty. We do not recall, however, any railroad mechanical department officer who has been recognized in this way.

The London Times in commenting on the birthday

honors mentioned Mr. Gresley as "engineer (and speeder-up) of the London & North Eastern Railway." To make his position more clear to American readers, he is the head of the mechanical department of a railroad which, according to the latest reports at hand, had 6,091 steam locomotives, 19,241 coaches, 254,825 freight cars and 44 steamboats. It is pointed out by the Railway Gazette (London) that "he inherited the big-boilered engine, an inheritance he has judiciously developed, all the heavy duty locomotives of this design having been equipped with that essential of reliable and efficient performance." He was also responsible, among many other innovations, for "the corridor tender which, by enabling enginemen to be relieved on the way, made possible the 392-mile non-stop run of the Flying Scotsman between London and Edinburgh, and the high-speed streamlined Silver Jubilee Express, which averages 70½ m.p.h. over the 232 miles non-stop between London and Darlington."

Mr. Gresley is also this year's president of the Institution of Mechanical Engineers. He is probably better known to American railroad officers than any mechanical-department officer outside the North American continent.

The Locomotive and Public Relations

The railroads have only awakened in the last few years to the prime importance of the locomotive in helping to make friends and boosters for them—and surely the railroads of this country are sorely in need of friends! Here and there at intervals in the '20s a mechanical-department officer would more or less timidly place a new or remodeled locomotive where the public could view it, but usually such a demonstration was made only at a shop point or at some important terminal, and was not systematically followed up with showings elsewhere.

Ed Hungerford, with his gift for pageantry and showmanship, put on the Fair of the Iron Horse at Halethorpe, Md., in connection with the Centenary of the Baltimore & Ohio in the fall of 1927; this he followed with the Wings of the Century at the Chicago Exposition in 1933-34; and now he is showing the Parade of the Years at the Great Lakes Exposition at Cleveland. No one can predict the extent of the favorable impression for the railroads which these pageants have made upon the minds of the American people. The high-speed streamline trains have likewise caught the imagination of the great multitudes. Indeed, in many instances they have undoubtedly gripped it more forcefully than the airplane and the dirigible. There is something more majestic, more powerful and at the same time more intimate, particularly in the case of the steam locomotive.

It does not require an entire train or a big spectacle to attract attention and make friends for the railroad. The Pennsylvania Railroad recently streamlined a Pacific type steam passenger locomotive at its Altoona Works. It was designed on the basis of painstaking experiments in the aerodynamic testing laboratory at New York University. The railroad has recently been exhibiting this locomotive at various points in the Western, Central and Eastern regions. Circus advertising is not being used. A bulletin is posted and a news item giving the time and place the locomotive will be shown is sent to local newspapers for such use as they may care to make of it.

Each day the locomotive is moved to a new community. In the first 11 cities in which it was shown in the Eastern region 103,347 people visited it. These cities had a total population in 1930 of 541,721, so that a goodly portion of the citizens was sufficiently interested, even under the extremely hot weather conditions, to go out of its way to see the locomotive. In Renova, Pa., a city of 3,947 inhabitants, according to the 1930 census, there were 4,026 visitors. At Lock Haven, Pa., 5,368 people examined the locomotive, the population of that city being less than 10,000.

What is being accomplished? "We are letting the public know that the railroads are progressing and keeping up with the times," said Walton Wentz. "I got this from conversations with those around the engine, whether they are 10-year old children, old men and women, business men, politicians, ministers, just plain hangers-on, and all who come to see the engine."

Another illustration of the fact that the public can readily be made more actively railroad-minded is the remarkable results which have accompanied the celebration of Railroad Week in the middle and western sections of the country. First tried last year, it was entered into so enthusiastically that it was again repeated this year and with even better results.

Railroads can utilize new or rebuilt locomotives to excellent advantage in cultivating the public and bringing about better understandings.

Shop Report Includes Important Conclusions

The report on consolidation and modernization of shops, which was issued on June 12 by the Federal Co-ordinator of Transportation, contains information of vital interest to mechanical department men who are concerned with the problem of maintenance of equipment.

Included in this report are the results of studies which have been made by various groups reporting to the Co-ordinator in recent months, as well as substantial information which emphasizes the magnitude of the problem with which the mechanical department must deal. While the report makes no recommendations for specialized action there are certain general conclusions that are of special significance.

Included in these conclusions are two statements of

special importance in relation to the equipment of locomotive and car repair shops. These are that "the continued use of obsolete facilities results in high costs of maintaining equipment not only in respect to actual work performed but also in respect to the quality of the work" and "no general program for replacing shop machinery should be adopted until a sound and balanced plan has been worked out in respect to the average condition of the locomotives and cars, repair schedules required to maintain that average, and the kind and location of repair facilities needed for the purpose."

In commenting on the maintenance of equipment problem, it has been consistently pointed out that cost of repair work in railroad shops is greater than need be because of the fact that such a large proportion—65 to 70 per cent—of the machine tools in the average railroad shops is considerably more than 20 years of age, and consequently unable to compete with modern machine tool equipment in efficiency of production, not to mention the fact that the advanced age of such machine tools necessarily involves large annual expenditures for maintenance.

It has also been pointed out that before any general program for replacing shop machinery is adopted, the problem of repair work on individual roads should be very carefully studied with the idea of developing information in considerably greater detail than has been the case in the past. Experience with machine tool replacement programs indicates that in so far as railroad shop machinery is concerned, there are certain types of machines which will produce a far greater return on the investment than other types due presumably to the fact that it is possible, because of the nature of the work, to use them more nearly to capacity.

The Co-ordinator's report points out the magnitude of the problem and gives us an excellent idea of the manner in which savings in equipment maintenance may be effected. It is important, however, for railroad men to realize that the obsolete facilities which are now in service in the shops are costing their companies money as long as they are continued in service, and that the manner in which these obsolete facilities can be replaced to the greatest advantage will depend upon the intelligence with which the replacement program is developed.

Included in the report are figures which indicate that over a 12-year period, from 1920 to 1931 inclusive, an average of $23,700,000 a year was expended for repairs on shop equipment involving a total investment of some 23 million dollars and that a substantial reduction of this amount might be effected, if a general policy of renewal of all machine tools was so planned that the average age of such tools would not exceed 7½ to 8 years, with an ultimate life of 16 years instead of 21.8 and 43.6 years respectively. The extent of the reductions in expenditures, chargeable to Account 302—Maintenance of Shop Machinery—is based upon the fact that the present expenditures amount to an average of 7.4 per cent on the investment, whereas experience in industrial plants has indicated that with machine tools having an average age of 10 years or less, the annual expenditure for maintenance should not be greater than 1.2 per cent on the investment.

Numerous studies which have been made indicate that the percentages involved, namely, 7.4 for the railroad shop and 1.2 for the industrial plant are accurate, and that a broad program of machine tool replacement resulting in a reduction in average age to from 10 to 15 years would result in savings in machine tool maintenance costs in the neighborhood of from 4 to 5 per cent on the investment. It is important, however, in making use of the general figures relating to the railroad industry, to point out that the figures relating to investment in shop machinery and maintenance of shop machinery include other items of shop facilities than machine tools. An examination of the details of Account 302 particularly, will show that this account includes not only repair expenses on many items of shop machinery other than machine tools but in most years this account has included substantial amounts which have been charged as a result of retiring old machine tools.

The important point in this connection is that because no detail figures are kept by most railroads relating to repairs to shop machinery, the extremely high cost of maintaining obsolete machinery has not been readily recognized. The amounts which have been so expended are sufficient to pay a very substantial part of the cost of replacing machine tools or shop equipment which have outlived their usefulness.

NEW BOOKS

HENSCHEL REVIEW. *Published by Henschel & Sohn A. G., Kassel, Germany. 100 Pages, 8½ in. by 11½ in. Printed in English.*

The last edition of Henschel Review, No. 5, December, 1935, is of special interest as it commemorates 100 years of German railways and 125 years of continuous operation of the company, which has constructed more than 23,000 locomotives. The first page shows in striking contrast the locomotive "Drache" built in 1848 and the latest German high-speed streamlined locomotive. In addition to well illustrated review articles on 100 years of German railways and express locomotive developments in the past 50 years, there are many illustrations of locomotives recently built. Other timely articles of particular interest cover a world wide illustrated review of streamlining (historical and recent); factors relating to and determining the application of steam, electric and internal-combustion locomotives; streamlined steam rail cars and locomotives, for the Lubeck-Buchen Railway; steered locomotive trucks; a condensing reciprocating steam locomotive for Russia; and the new standardized locomotives for the Chilean State Railway.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Quiet Place for Conference

Recently I heard the following remark in the office of the erecting shop foreman:

"Let's go down to the boiler shop office; it is too noisy here for our meeting."

As an actual fact, due to the extended use of pneumatic tools, there is frequently found to be much more noise in the erecting shop than in the boiler shop, where the quieter operations only are performed, such as laying out, rolling, flanging, fitting up and staying. The noise-creating operations appear to be performed now in the erecting shop.

And so the boiler shop office was chosen for the conference!

Old Plant Speeded Up!

There are many opportunities to improve shop operations. Old plants have been rejuvenated, not only by the acquisition of a number of new tools but by the application of electric power replacing the old steam plant. I have in mind a locomotive shop, 45 years old, which, by simply uncoupling the main line shaft and applying motors at subdivisions and countershafts, made it possible to increase the speed from 80 r.p.m. to 200 r.p.m. The current was secured from a traction line at a low price by keeping off peak. You can imagine the result in efficiency and reduced cost. The whole change was made at a very moderate expenditure.

Threatened Shortage of Skilled Workers

I like to read your articles on apprenticeship. I believe we are heading right into difficulties, due to a shortage of railway craftsmen. I believe that if I was instructed to suddenly increase my staff of mechanics 10 per cent, I could not do so with competent men. I know of no railway blacksmiths out of work, nor in work who would quit and come to a railway shop under present conditions. Good pipefitters also are scarce. I could pick up a few boilermakers; welders are capturing some of the jobs from boilermakers. Machinists would be difficult to get unless you took them away from another railway. We have always managed to regulate our apprentice system so that it would balance our payroll separations, but if the retirement pension at 65 goes into effect, extra railway craftsmen will be hard to find.

The Boilermaker Speaks

Jones, the boilermaker, called attention to the merits of welded flues, making it possible for locomotives to stay on the road on extended runs of 24 hours, or more, and reach the terminals with no leaks to speak of, anywhere about the firebox. And the proper treatment of the boiler feedwater is a great factor in making every locomotive a free steamer and easy on the coal pile. He mentioned the fact that in the old days, before feedwater treatment was the practice, it was a common thing to bush the exhaust nozzle to provide stronger draft on the fire to make up for the loss occasioned by the accumulation of scale on the flues and firebox sheets, which was often ⅛-in. to ¼-in. in thickness. Bushing down the exhaust nozzle increased the back pressure and the fuel record went glimmering. After all, there is nothing like a clean boiler to make engines show up good on fuel performance and the lower maintenance costs of firebox repairs more than offsets the expense of treating the water.

Principal Source of Information

As you know, the financial condition of our railroads has prevented supervisors visiting other shops for exchange of ideas and practices, and our principal source of knowledge of improvements on other lines is necessarily limited to what is published in your magazine.

How About the Answers?

I am more interested, personally, in articles dealing with design and maintenance of present equipment. Questions similar to the following are always suggesting themselves:

What changes can be made in drafting appliances, or grates, or both, to make a better steaming and a more economical engine?

When you get back pressure down reasonably low is it an advantage to go lower at the expense of superheat?

Is it good practice to superheat much above a point where exhaust steam carries superheat?

Are floating bushing driving boxes and solid tip ends an improvement over the old style crown brass and split tip end brass?

Hot Engine Truck Boxes and Hot Rods

The cellar packer, who is known around the roundhouse as the "lubrication expert," says it is now a rare occurrence to cut out an engine on account of a hot truck box, since the engines on the long runs have been equipped with the new style cellars on the engine trucks and trailers. He further states that the 'hot rod' proposition is well in hand since the rods have been equipped with the new style rod cup fittings and it is so much quicker to fill rod cups with the new air-operated grease gun, as compared to the old screwed plugs and the wrenches used by the hand method.

Why Long Locomotive Runs Are a Success

Recently I overheard a discussion that arose a few minutes before the whistle blew to start the shift, and talk centered about the thing that the men thought most beneficial in making the extended locomotive runs successful. The gang boss thought it was for the most part made possible by the new set-up of giving engines classified repairs at regular intervals. Also the fuel performance was materially helped by having the bore of the cylinders and the valve chambers in first-class condition. It was thought that the increase in the miles run per engine failure was also due to good inspection being made while engines are being stripped for repairs.

Cultivating the Public

Of course, I recognize that the curious were there (visiting the Pennsylvania Railroad's new streamlined, coal burning passenger locomotive recently completed at its Altoona works); also hundreds of little children in every town. I checked the faces of these little run-about children at two points. I saw them at the engine in the forenoon. I think it was in Williamsport in the evening that I heard a little fellow say, "There's the man," and when I looked around (out of pure curiosity on my part) he was pointing at me, and it was a little chap to whom I had been talking in the morning. I had simply said, "Run up there, Sonny, and look in the engine cab and see where the engineer sits." There he was in the evening, all cleaned up, hair combed, 'n' everything, and his father and mother were with him, all freshly dressed for the evening. They were "the public"—in other words, I asked a friend of mine who knew the man whether he was a railroader and he said the man was in business.

IN THE BACK SHOP AND ENGINEHOUSE

Bronze Welding And Brazing*

By Homer Gannett

In the past 15 years we have witnessed the rapid development of bronze welding and brazing. These developments have been in both the oxy-acetylene and the arc-welding processes. This progress, however, has not been accomplished without many experiments and some failures.

In the early stages of brazing of cast iron, we met with some difficulty in obtaining the proper adhesion to the castings. This brought about the question of a good chemical flux that would act as a scavenger, removing all foreign substance, and thus permit the bronze to adhere to the metal. We also found that the surface must be properly prepared; fractures and breaks must be beveled; and sufficient clearance provided to permit the bronze to flow through the entire section. In many cases, it is essential to preheat the casting to obtain the proper expansion to allow for the contraction of the weld.

Through these experiments, brazing and bronze welding is fast becoming an art recognized by many railroads as a standard procedure of reclaiming broken and worn material; also for building up worn surfaces with attendant large savings and economies in shop operation.

I would like to point out a few reasons why brazing will increase production at a saving. The rapid rate of deposition, which is several times greater than with any other metal, reduces the labor time, and the material being brazed or bronze welded is subjected to the least amount of heat possible. This tends to minimize the amount of internal stress within the welded area.

Several years ago we did not think that the brazing of broken locomotive cylinders would ever be successful, but we find that this operation is today very satisfactory in most all cases. However, there are some locations in locomotive cylinders that are very difficult to braze. This is due to the unequal expansion and contraction as well as the difficulty in reaching these locations. We also find that many emergency jobs that cannot be held long enough to weld with steel, are satisfactorily brazed. This pertains to running repair work, such as frames, etc.

Many railroads find that the reclamation of malleable car parts are more satisfactory when bronze is used. This is due to the fact that the bronze is applied without raising the temperature of the malleable to the critical point. Therefore, the structure of the malleable is changed very little.

We also find a large field for bronze welding, and brazing on bearing parts, such as the jaws of valve motion parts; crosshead shoes (cylinder and valve); welding on brass liners to driving boxes; both hub and pedestal, and other such parts.

The general procedure in bronzing worn crosshead shoes is to apply a bronze rib about two inches or wider on each side and one or two in the center, and fill in between with babbitt. However, I have witnessed a very satisfactory method on Laird guide shoes where the shoe is forged of steel and then faced with bronze. This method in many cases is more satisfactory than the solid brass shoe. Due to the difference in expansion, the steel faced shoe can be set up with less lateral; therefore, it should create less hammering.

We also find that many railroads are successfully bronzing worn piston heads and bull rings. This success depends largely on the preparation of the work before being bronzed; also, on the skill of the operator in applying the bronze without burning it and yet obtaining good adhesion.

Piston heads saturated with oil are difficult to bronze and obtain a solid deposit. A porous deposit of bronze reduces the bearing surface considerably. Therefore, I believe that the success of bronze welding and brazing is assured only when the material is properly prepared and the welding and brazing performed by a qualified operator.

* Presented by Homer Gannett, welding supervisor, Chicago, Burlington & Quincy, at the Midwest Welding Conference, held under the auspices of the Hollup Corporation at Chicago on June 5.

Stopping Small Losses Results in Large Savings

By W. B. Foster

We are inclined to think always of value as money and to look upon material other than money as being simply different kinds of matter kept for convenience and to be used freely whenever and wherever desired. Yet we know that a man with a home paid for and but one dollar in cash to his name is wealthier than his neighbor with a hundred dollars in coin and no other possessions, wealthier because the quantity of other material he possesses has more value than the quantity of the material called money.

Money is only one of the many different kinds of material in existence. For centuries people lived, increased, and thrived without it. Trade was based on comprehension of the value existing in all kinds of material and the part each plays in contributing to man's wealth and prosperity.

We are likely to think of sand only as dirt; paint as

Here is half a dollar picked up casually on the way to the roundhouse

merely liquid; rope as strings of wool and cotton; gaskets as bits of rubber; rivets, rough metal; unions, cold iron; rails, cold steel; boards, just wood; globes, thin bits of glass; machines, assemblies of metal; buildings, convenient shelters. We search hard for a lost nickel and walk straight by a leaky oilpipe that will let many nickels drip away forever. We never allow small change to lie scattered over an engine, but we let the same engine go out with material on the deck, the bumper and the running boards, to be jarred off and lost along the right-of-way.

This carelessness is a paradox of human nature, but we do comprehend the value in materials and often display our realization of it unconsciously. If we are given the choice of a dime or a good dinner we take the materials on the table and call it a cheap price for a meal.

We know, from our own experience that every kind of material is value. No matter whether we call it a dime, a poker, a bottle, a tire or a chair, each piece of material has a certain worth to obtain which we have to give something in exchange. As long as we have it or its equal in value the worth of our possessions remains unchanged. But if we consume it or lose it or waste it we reduce the worth of our property accordingly. This is why such strenuous efforts have been and are continually being made on the railroads to find ways and means to save material. It is one of the major steps toward preserving the value of the company on whose worth our livelihood depends.

True saving of material is not accomplished by being stingy with it. Keeping it on the shelf when it ought to be used may result in failures and trouble that will

It took three minutes to pick this thirty-three cents off the "scrap-pile tree"

cost many times its value. Letting the loose ends go frays out the warp; a rip unmended lengthens; a bolt applied without nut or cotter is soon lost. Incomplete repairs leave open the door to failures that lead not only to waste of material but also to other loss of property and to personal inury. Many a dollar has been paid in claims for damaged freight or clothing or in compensation for personal injuries, because someone somewhere neglected a crack in a car roof, the fastenings of a car seat, a split rung in a ladder, or some other defective condition. "A stitch in time saves nine," and we should use whatever material is necessary to proper operation and maintenance.

Reducing Necessity for Use a Real Saving

The requirement of a real saving in material is to find ways to reduce the necessity for using it. This can be accomplished, first, by doing away with unnecessary facilities and equipment, and second, by eliminating conditions which involve waste of material that does have

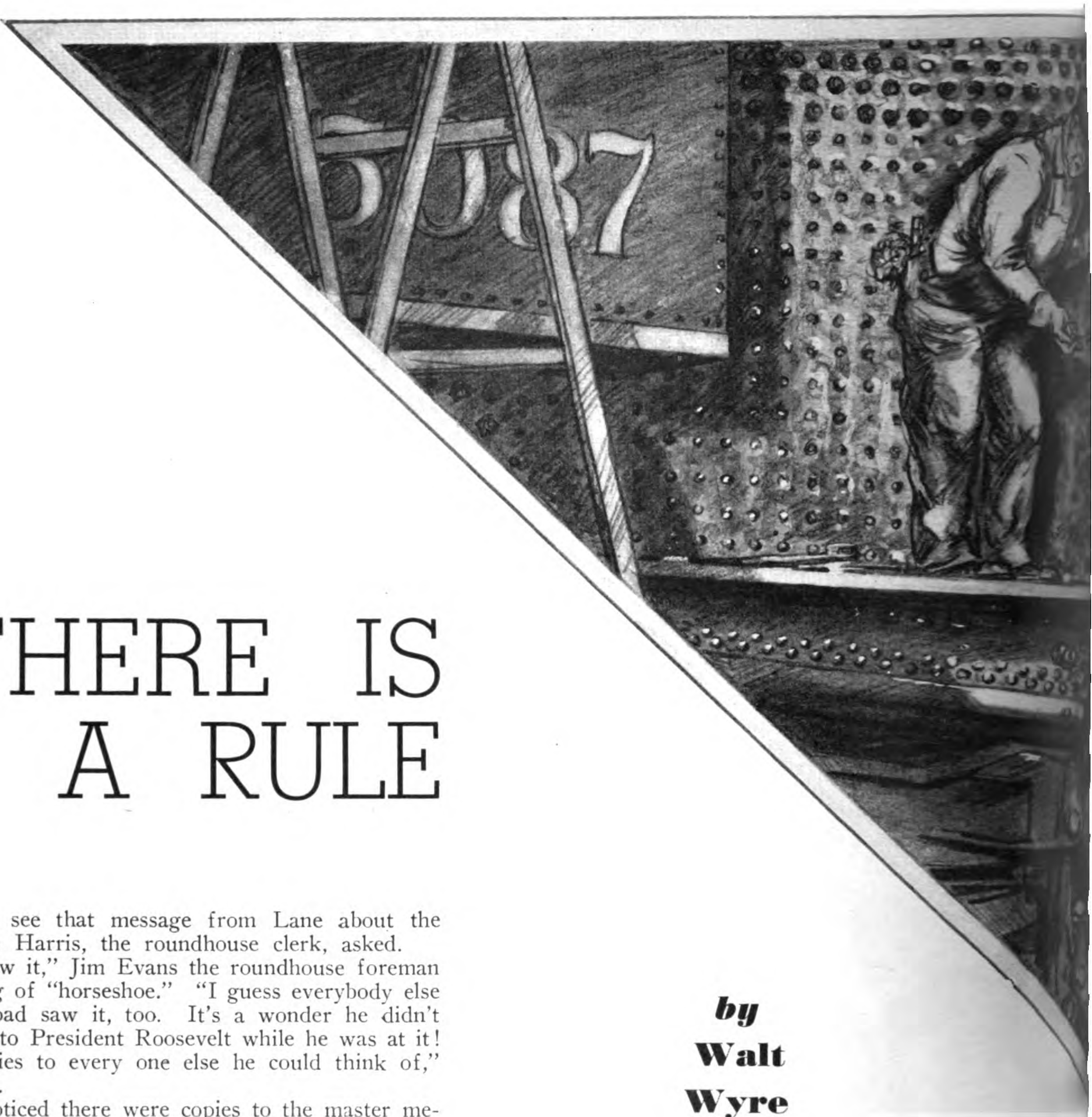
A rod bushing, before and after the pattern was changed to eliminate the purchase of unnecessary material and waste of time in machining it off

to be used. These methods not only result in actual reduction of expenses but also (and here is where the great benefit comes in) make the savings continuous and permanent. They do not save today and lose tomorrow, but get at the root of the trouble and establish a saving that repeats itself day after day. Any other means is but temporary relief; finding the way to reduce the need for material is a permanent cure. Let us look at a few cases from actual experience which illustrate the scope of opportunities for making such cures.

In one train yard were nine toilet buildings, averaging one for each switching crew employed there. The yard was not very large and furthermore was adjacent to a shop with ample washroom facilities for all employes in the vicinity. The building farthest from the shop was left, the other eight were removed. They were a source of unnecessary expenditures for construction and maintenance as well as of fire hazard and of dangerous obstruction to employes working throughout the yard.

Certain appliances on locomotives were equipped with valves which by reason of their location were frequently knocked off and broken. Replacements cost several dollars each. A way was found to operate properly without them and they were removed permanently, saving not only the cost of the repeated replacements but also the loss of man-hours and engine service which was resulting from tying up the locomotives for repairs.

(*Continued on page 362*)



THERE IS A RULE

by **Walt Wyre**

"DID you see that message from Lane about the 5079?" John Harris, the roundhouse clerk, asked.

"Yes, I saw it," Jim Evans the roundhouse foreman bit off a slug of "horseshoe." "I guess everybody else on the railroad saw it, too. It's a wonder he didn't send a copy to President Roosevelt while he was at it! He sent copies to every one else he could think of," Evans added.

"Yes, I noticed there were copies to the master mechanic, superintendent, and superintendent of motive power. Looks like he wants to advertise it all over the railroad when an engine comes in from Plainville needing a little work," Harris said. "I have an idea we have engines come in here from Sanford in lots worse shape than with a broken spring hanger," the clerk added.

"Not to hear him tell it! According to him the reason his M. of E. charge runs up is because of so much work on engines we dispatch from Plainville." Evans had his mouth so full of tobacco juice that he was beginning to gurgle. He fished the cuspidor from under the desk with his foot and expectorated a lusty stream. "Yeah, if Lane was half as anxious to get the work done on engines as he is to holler about what we don't do, we'd all get along better."

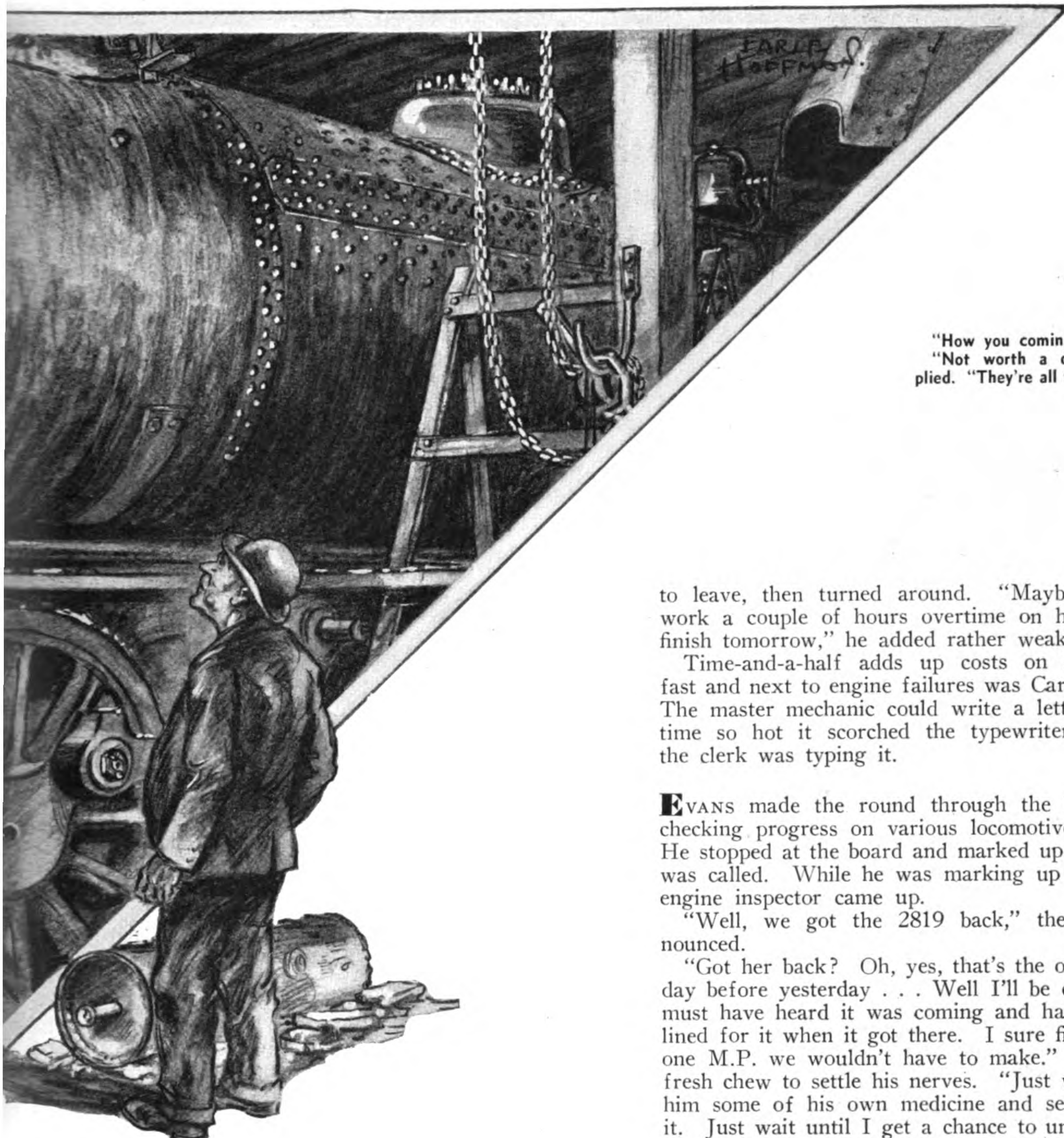
"They all belong to the S. P. & W., don't they?" Harris stated rather than asked.

"Yeah, they all belong to the S. P. & W., but Lane likes to make a showing. He figures that by shooting all power back here that needs work he can keep his own costs down and by hollering his head off about work needed on locomotives we dispatch he'll make everybody think he could do still better except for having to do work we should do here. I'm getting blamed tired of it, too! Why, it's getting so that Lane figures to a minute on getting engines back here for M.P. inspections. The 5080 that came in on No. 9 at 10:50 last night was due an annual at midnight. Huh!" Evans snorted and headed for the roundhouse.

The foreman went by stall number 12 to see how the boilermakers were getting along with the 5087. The engine was in for a five-year test. The jacket and lagging had been removed. Barton was taking off flexible staybolt caps. The boilermaker was pulling, panting, and swearing. Pulling on a buggy bar inserted in a box wrench was making him pant and a staybolt cap that wouldn't budge was causing him to swear. The boilermaker heaved and grunted, but to no avail. He slammed the wrench and bar down and grabbed hammer and chisel. He finally managed to jar the cap loose, but not until he had cut two corners off the cap and left a deep gash on a third.

"How you coming?" Evans asked.

"Not worth a damn!" Barton replied. "They're all



"How you coming?" Evans asked. "Not worth a damn!" Barton replied. "They're all tight as thunder—"

tight as thunder—have to use a hammer'n chisel on every one of 'em." The boilermaker glanced at the scarred remains of the cap in his hand.

"Well, get it done soon as you can. We need that engine right now—need it bad. Do you suppose you can get it done so the coppersmiths can start putting the lagging and jacket back on tomorrow?"

"'Fraid not; we could if we had one of them impact wrenches, though."

"What do you mean, those new wrenches we saw advertised last month?" Evans inquired.

"Yes. They're just the thing for a job like this—get it done in half the time and lots easier, too. Why don't you talk to the master mechanic about ordering one. There are lots of places it would come in handy around here, save a lot of money," Barton added, knowing that the economy angle would be more likely to get the wrench than the fact that it would make the work easier.

"I'll see about it," the foreman said, and started to leave, then turned around. "Maybe you'd better work a couple of hours overtime on her so you can finish tomorrow," he added rather weakly.

Time-and-a-half adds up costs on repairs mighty fast and next to engine failures was Carter's pet peeve. The master mechanic could write a letter about overtime so hot it scorched the typewriter ribbon when the clerk was typing it.

Evans made the round through the house mentally checking progress on various locomotives as he went. He stopped at the board and marked up an engine that was called. While he was marking up the board, the engine inspector came up.

"Well, we got the 2819 back," the inspector announced.

"Got her back? Oh, yes, that's the one we run east day before yesterday . . . Well I'll be damned! Lane must have heard it was coming and had the turntable lined for it when it got there. I sure figured that was one M.P. we wouldn't have to make." Evans took a fresh chew to settle his nerves. "Just wait! I'll hand him some of his own medicine and see how he likes it. Just wait until I get a chance to unload something on him!" Evans strode back to the roundhouse office swearing under his breath and spitting every third step.

"Dispatcher wants a 5000 for a drag east at four o'clock," the clerk told Evans when he reached the office. "What'll I give him?"

"Well, let's see. We got to use the 5072 on the Limited and the 5081 on 71. Wouldn't the dispatcher take a 2800?"

"No; I asked him. He said there would be too much; have to have a 5000."

Evans slumped down in a chair to think the situation over. "I've got it!" he announced. "We'll use the 5091."

"But I thought you were going to hold her for a set of tires," Harris reminded him.

"I was, but we'll just let Lane have her. The driving-boxes are pounding, too. Just make a wire to Lane telling him about it. He sent her up here; I'll just be as good as he was, and send her back to him." Evans chuckled and leaned back in his chair.

About ten o'clock next morning the messenger laid

a message on the clerk's desk. Harris read it and handed the yellow slip of paper to Evans: "Engine 5091 in Sanford this date. Driver tires worn to limit, driving boxes pounding bad. Rod bushings need renewing."

The message was from the foreman at Sanford. In the lower left-hand corner was marked: "cc-F.R.Rines; H.H.Carter."

"Lane didn't waste any time letting the superintendent and master mechanic know about the 5091," Harris observed.

"Lot of good it'll do him. He sure won't have the gall to send it back in the shape it's in. If he did and a government inspector happened along, it would be just too bad." Evans grinned at the thought as he sat down to look over some work reports before taking them to the roundhouse.

Just as the foreman was starting to leave, the phone rang. The foreman paused a moment to find out who it was and what was wanted.

"They want a 2800 for a work train in the morning; be out all week or longer," the clerk said.

"People in Hell crave air-conditioning, too!" Evans replied. "Tell him I'll have to look things over and let him know later . . . Already two engines short and they decide to run a work train! A person would think the way they go off half cocked sometimes that the Government was running the road." The foreman headed for the roundhouse in high spirits in spite of the shortage of engines.

After looking things over, Evans decided on the 2822 for the work train. It wasn't quite ready to fall apart, but still wasn't in shape for heavy road service.

In stall number 12, Evans found work on the 5087 progressing as well as he expected. A coat of red lead had been applied to the boiler and the engine was ready for the asbestos lagging. If things went O.K., he could get it out in time to run the next night.

The 5076 came in on No. 10 dragging like a mechanic with a Monday morning hangover. "The blamed engine hasn't got power enough to pull a drunk brakeman out of service!" the engineer told the foreman. "Cylinder packing down."

Evans asked, "Which side?"

"Which side? The way it acts, there ain't no rings on either side. Both sides are blowing so bad the engine don't exhaust, it just whooches. And the right valve, too, it's just as bad. Then they wonder why we can't make time!" The engineer snorted and went in the wash room.

Evans went in the office. "How's it going?" he asked the clerk.

"There'll be two sections of No. 9 tonight," Harris told him, "and the dispatcher wants a 2800 for a stock pick-up east at 4:30."

"Well, looks like we might be a little short on power tomorrow, but we ought to make it. I'd better have the hostler get the 5076 in the house right away so they can get started to work on her."

After lunch, Evans, as usual, made a tour of the roundhouse. Machinist Jenkins had pulled both pistons from the 5076 and was starting on the right valve.

"How does she look?" the foreman asked.

"The packing is down on both pistons, pretty bad. I don't know how the valve is. I'll have it out in a little bit."

At that moment Jenkins' helper returned with a package in his hand. "They didn't have but one set of piston packing in the storeroom," the helper announced as he laid the package containing the sectional packing rings on the pilot beam.

"What we going to do about that?" the machinist asked.

"Nothing we can do except put in the one set and wait until we get another. Soon as we see what the valve needs, I'll go down and have the storekeeper send a hot wire about it."

"Need new valve bushings," Jenkins said when he and his helper had pulled the right valve piston out.

And it did need new bushings. Both front and back were badly cut out. The valve showed signs of having been blowing badly.

"I'll have valve bushing castings sent to the machine shop while I'm at the storeroom," Evans said as he started away.

He didn't have the castings sent from the storeroom for the very good reason that there weren't any to send.

"Shall I go ahead and get the bushings cut out?" the machinist asked.

"No; put in the set of cylinder packing and let the rest go for the present. You and your helper can go down to the 5087 and help get her out. Looks like we're going to need her before she's done."

NEXT morning things started off all haywire and from there got worse. There was a message saying that the engine on the work train had a bad leak in the fire-box and would have to be relieved for repairs. There was another message that didn't cheer Evans up any. It was a notice from the foreman at Middleton, the west end of the division, saying that the government inspector would probably be in Plainville that day. Then just to add variety to the general mess of misery that was being cooked for serving that day, the 5074 had failed on No. 10. A crank arm broke and the eccentric rod slammed things around quite a bit before tying itself in a bow-knot.

"Now if we can just manage to get a couple of Form 5's, that ought to help a lot," Evans said sarcastically and bit off a hunk of "horseshoe."

The government inspector showed up about 10:30. Evans was out in the roundhouse at the time pushing work on the 5086. Mechanics were hurrying helter-skelter looking for parts and fittings that had either been mislaid or used for repairs on other engines. The painter was trying to spray the jacket amid a barrage of profanity from mechanics that were in his way. The electrician was threatening to start throwing things if the painter didn't stop or turn the spray gun in another direction.

"Just a nice happy family," the government inspector remarked grinning.

"Yeah, oh, hello, Mr. Turner! Glad to see you." Evans lied glibly. "Just a moment and I'll be ready to go with you soon as I get things organized on this Tower of Babel."

"Don't you want to go to the office and slip on some overalls?" Evans asked when he and the government inspector had started down through the house together.

"No, not now," Turner replied. "I'm going up to the hotel and make out some reports. I'm not going to bother you much this trip. I may drop back a while this afternoon."

"Won't you go out to the house with me for lunch?" the foreman invited.

"No, thanks, I'll have a bite up town."

"Well, I'll tell the wife you'll be out for dinner then," Evans suggested.

"Thanks again," Turner replied, "but guess I'll have to take a rain check and make it some other time. I'm getting out this evening, going east."

At the lunch room he ran into the government inspector.

"Sorry you can't come," the foreman replied, immensely relieved, not because Turner had declined the invitations to eat but because he had learned that the government inspector's plans didn't include a fine toothed inspection of the locomotives at Plainville.

Turner had been gone about twenty minutes when a 5000 whistle announced the arrival of a westbound drag. Evans at his desk cocked his ear to listen. There was something vaguely familiar in the tone of the whistle, but the foreman didn't recognize the engine. At times he could recognize locomotive whistles in spite of them being standardized and operated by automatic whistler blowers.

A few moments later the drag pulled in the yard. The locomotive came clanking by the roundhouse. Then Evans swore—vehemently and volubly. At the head end of the drag, puffing derisively, was the 5091, worn tires, pounding driving-boxes and all. Lane had taken a chance and sent the engine back to Plainville.

"Of all the blasted nerve—sending that engine back here in that shape! Make a wire to Lane with a copy to everybody on the railroad telling about it. Make it plenty strong!" Evans fumed.

Harris reached for a pad of yellow clip. Pencil poised over the paper, he waited while Evans sat with puckered brow eyeing the floor. "What shall I tell him?" the clerk asked.

"Tell him the 5091 in Plainville from Sanford this date in very bad condition, tires worn past the limit, driving-boxes worn, and other Federal defects . . . Wait a minute; tear that up! It sounds too much like the way Lane does, too much like snitching. Besides, I've got a better plan."

Harris crumpled the paper in a ball and tossed it in the waste paper basket.

"What time is the next one going east?" Evans asked.

"There's one doped for 1:30. Ought to get a call on it any minute now. It's a fruit train and will have to get over the road," the clerk reminded him.

"That's O.K. The 5091 will run if it don't fall to pieces. I'll just send her right back to him. Turner will be there tomorrow and Lane won't dare try to run her. If he does Turner'll slap a Form 5 on her so hard it'll bounce. Serve him right, too. Lane, I mean, for the way he's been dodging work and scattering carbon copies of messages over the railroad. That'll fix him!" Evans said emphatically.

"Yeah," Harris replied, "if he gets a Form 5, it'll teach him something. They sure are getting hard about Form 5's on this railroad."

"Well, when the dispatcher calls, give him the 5091," Evans said and left for a turn through the roundhouse.

SOMEHOW Evans didn't feel as elated over the prospects for getting even with Lane as he thought he would. Even reminding himself of the many things the foreman at Sanford had pulled on him didn't entirely satisfy his conscience.

Without knowing exactly why, Evans decided to go to lunch early and on impulse decided to eat in town. He called his wife and told her not to look for him and about 11:30 went to town.

At the lunch room he ran into the government inspector. "Sit down," Turned invited. "Thought you were going home to lunch."

"Changed my mind. Don't want anything but a cup of coffee and a piece of pie. My wife always gets anxious when I don't eat," Evans explained. "I have my car; if you will be ready to go back to the shop, I'll take you down," he added.

"No, I won't be down for a couple of hours. Didn't finish my reports and want to get them off first. You're too anxious," Turner added jokingly. "I'm afraid Lane won't be so glad to see me, though."

"Oh, I don't imagine he'll mind. You're not so bad, if a man gets the job done," Evans replied.

"That's just the trouble. I've warned Lane several times. He's had plenty of chances and the railroad officials know it, too. About one more Form 5 and it'll be too bad. I'd hate to have to do it, but if I have to, I will."

Evans finished his pie and coffee. "Say you're not ready to go to the shop?"

"No; see you later on."

Evans didn't linger. He rushed back to the shop. The 5091 was on the outbound track waiting for the engine crew.

Evans pictured in his mind just what would happen in Sanford. The 5091 would get in early next morning. She'd be setting outside when Lane came to work. Running true to form, Lane would give orders for the engine to be turned and run west. Knowing Turner's habits pretty well, Evans figured that the inspector would reach the roundhouse just about time the 5091 was set out on the lead, then wham! A Form 5 so quick it would make Lane dizzy. Evans frowned and bit off a hunk of "horseshoe." There wasn't another engine ready or that could be gotten ready.

The twelve o'clock whistle interrupted his meditation. He turned on his heel and headed for the office. Employees were already beginning to check out when he got there. He looked down the line of overalled men. "Here, Jenkins, and Williams," he called to two machinists. "You and your helpers work noon hour on the 5076. Get her back together ready to go. I'll be with you in a minute."

"Call the dispatcher and tell him to change the engine on the fruit train, I'm using the 5076," Evans told the clerk.

"Reckon she can make the time?" the clerk asked.

"I kinda doubt it, but we'll take a chance, and give the engineer a note to Lane telling him the government inspector will be there tomorrow with blood in his eye," Evans added as he left.

Somehow the letter Evans received about the 5076 losing two hours on the run didn't have the sting such letters usually have, even if it wasn't written any different.

Stopping Small Losses Results in Large Savings

(Continued from page 357)

Counting certain small items to check receipts against invoices took much time because of the number used. The units were of uniform size and it was found that the number could be ascertained accurately and many times more quickly by weighing instead of counting.

Part of the roof of a building loosened; a gust of wind completed the loosening process and ripped off some boards. In falling they narrowly missed a man who had just come out of the building; they splintered into matchwood; and so much rain poured through the hole that work was badly hampered and part of a job spoiled. All this danger and damage would not have occurred if, when the boards were first loosened they had been nailed back into place. Cost of new boards, loss of man-hours, expense of duplicating the job that was spoiled, all could have been avoided.

Three metal buildings were erected for a certain purpose at three widely separated points. Two of the buildings were kept painted; the third was let go. Rust got in its work so that it was necessary finally to renew the entire roof and most of the sides of the latter at a cost many times the value of the paint and the labor which had been put on the other two buildings, both of which continued in excellent condition.

Check of a certain casting showed the pattern was much too large. A change in the dimensions reduced the weight 40 per cent, which not only cut down the original purchase price but also saved much labor in handling and in machining to fit when used. The annual saving in purchases on this one casting was about 16,000 lb.

Another casting had a heavy boss or projection on one end to fit into a pocket of the equipment on which it was used. The pocket had later been eliminated but the casting had not been changed; the result was purchase of extra material which only had to be machined off before the casting would fit. Changes in this pattern produced decided savings in both material and labor costs.

A complete check of all castings uncovered similar conditions correction of which eliminated the purchase of thousands of pounds of material annually and saved hundreds of man-hours formerly consumed in machining away the surplus stock.

A requisition was submitted for two panelboards for electric-light switches, due to the boards in use being too small to accommodate added switches required. Check-up showed that added space was needed as stated in both cases; but it also showed that one board was much larger than the other and could be used to replace the smaller board and thereby leave but one panel to be purchased.

A welding job was conducted under one of the two main processes used today. A study showed that in this particular work the other process was much more economical. The change saved thousands of dollars annually.

An oil reclaiming process required blotters which had to be replaced after being used a few times. Investigation showed that a different grade of blotter was more economical not only in first cost but also service obtained. An old axiom says: "The best is always the cheapest." Here was a case where the cheapest was in every respect the best, the blotter which proved most suitable being the lowest-priced among all those tested.

Rods, pipes, and other parts headed for the scrap pile were found to be carrying with them good fittings such as plugs, valves, and similar items. A program of reclaiming these items netted a considerable saving.

A moving part made of brass required frequent replacements. The casting was changed to steel with brass lining which could be rebuilt when worn. The result was the complete elimination of new purchases of the castings, with only the expense of relining as required.

At one point water was being purchased at a cost of several hundred dollars a month. A well was driven and an automatic pump installed which supplied the same amount of water thereafter at a saving of about 75 per cent of the cost when purchased. A similar check at another point developed a saving of about 85 per cent.

It was found that a good scrubbing will frequently

take the place of a paint job, removal of dirt being often all that is necessary to freshen up a surface. As soap is much cheaper than paint this produced decided savings in renovating cabooses, stop-blocks in roundhouse stalls and other equipment.

The annual bill for certain oilcups ran into four figures. Now these cups have a very easy job. They just go along for the ride, doing no hard work, under no strain, with no moving parts or complicated mechanism, with only a tiny hole in the center through which the oil feeds. Why, then, should they be replaced so often? To find out, each man applying them was requested to turn in the old for the new so they could be examined for failure. The chief defect was holes plugged up. All concerned were specially lined up to keep cups cleaned; the result was almost endless life for the cups and reduction of purchases practically to zero.

This item answers a question that has been asked many times: "Why is it necessary to turn in this or that old material when new is drawn out?" Requiring old material for new is just one step in the primary requisite for reducing bills, namely, to find a way to reduce the necessity for purchases. To learn why a thing fails obviously necessitates finding out what is wrong with it. To do this necessitates examining it. Thus we find, perchance, weak construction at some point; defective material in some section; evidence of unfair usage; indication of excessive heat, pressure, or other abnormal condition; a variety of clues that help to solve the puzzle of why we use so much of a certain item. Having determined why it gives trouble, we can take steps to correct any wrong condition and thus get more service out of it. Consequently we do not have to buy new units so often, and the benefits of a new saving begin to appear.

There are some kinds of material of which the used are required as a check against loss by theft. Electric bulbs, putty knives, tapelines, and thermometers are in this class. Such articles are of common use, handy around any house or in any business. It would be a simple matter to tuck these away and remove them from the railroad property if there were no close check kept on the reason for the replacements.

Waste is a drain on any treasury, which, if too long unchecked, will end in bankruptcy.

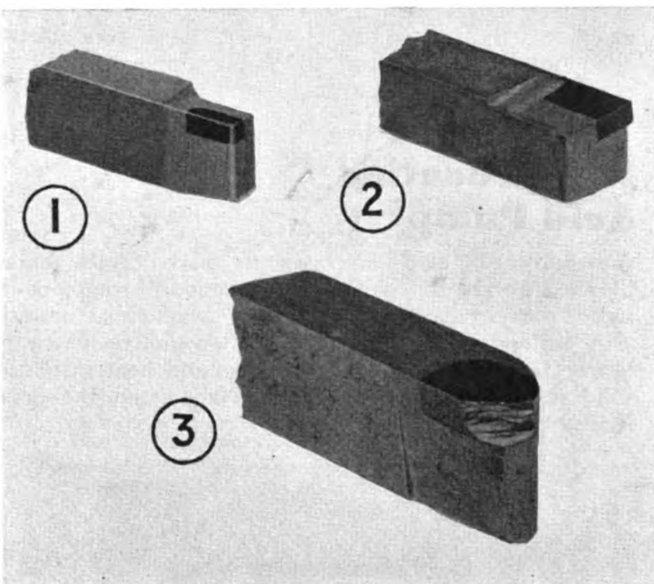
Rapid Grinding Technique For Carbide Tools

The Carboloy Company, Inc., Detroit, Mich., manufacturers of Carboloy cemented carbide tools and dies, recently completed a series of educational demonstrations in various cities showing an improved technique for grinding carbide tools.

This latest technique is of unusual interest to users of Carbide tools because of the drastic reduction in carbide tool grinding time made possible by following the recommended procedure.

Examples of the remarkably short periods now required to grind various types of carbide tools are shown in the accompanying illustrations. The tool, (size ⅝-in. x 1¼-in.) shown at (1) in the illustration is typical of one dulled through ordinary use. It requires regrinding on the front and side clearances only. The average time required to completely resharpen a tool of this type, following the latest procedure, as shown at the demonstration, is between two and three minutes. The average time using previous methods would be from 20 to 40 min. A "milled and brazed" carbide tool is shown at (2). "Milled and brazed" carbide tools are ones released by the manufacturer directly after the carbide tip has been brazed to the steel shank. Such tools require complete grinding on all surfaces at the cutting end of the tool, and ordinarily to grind a tool ⅝-in. x 1¼-in., for example, would require from one to two hours. Under the new procedure, a tool this size can be completely conditioned in 4½ to 7 min. This greatly reduced grinding time is also found to be of benefit in the case of carbide tools chipped through accidental abuse. The tool shown at (3) is one of this kind (size ½-in. x ¾-in.) chipped to a depth of about $^3/_{16}$-in. Frequently a tool in this condition might be considered a total loss and scrapped, due to the excessive amount of time required to recondition. Using the latest, improved technique it is stated that this tool can be completely reground in about 3 min.

The demonstrations of this latest procedure revealed several features which are important factors in making possible such drastic reductions in the time required for grinding carbide tools. These are: (1) The proper dressing of grinding wheels for rapid grinding. (2) the maintenance of constant motion of the tool while grind-



(1)—A dulled tool to be reground; (2)—A milled and brazed tool ready for grinding; (3)—A carbide tool chipped through accidental abuse.

ing. (3) the use of double or composite angles in the tools, and (4) alternate grinding on the carbide tip and steel shank when necessary to hog off large amounts of stock, as in the case of chipped carbide tools.

Regarding the first requirements—that of dressing the grinding wheels—the procedure followed for the roughing and semi-finishing operations on the face of a cup wheel, or on the periphery of a straight wheel was to shape a slight crown about $^1/_{16}$-in. high on the wheel. The area of contact is thus held at a minimum and excessive generation of heat thus avoided. The face of a cup wheel dressed flat, as usual, was recommended for finish grinding. The second factor—maintenance of constant tool motion—involved the steady motion of the tool across the surface of the wheel, and also the use of a rocking, or tilting, motion of the tool from side to side while roughing and semi-finishing. This avoids excessive grinding at any one spot on the tool and provides further means of avoiding excessive heat—an important factor if rapid grinding of carbides is to be successfully accomplished.

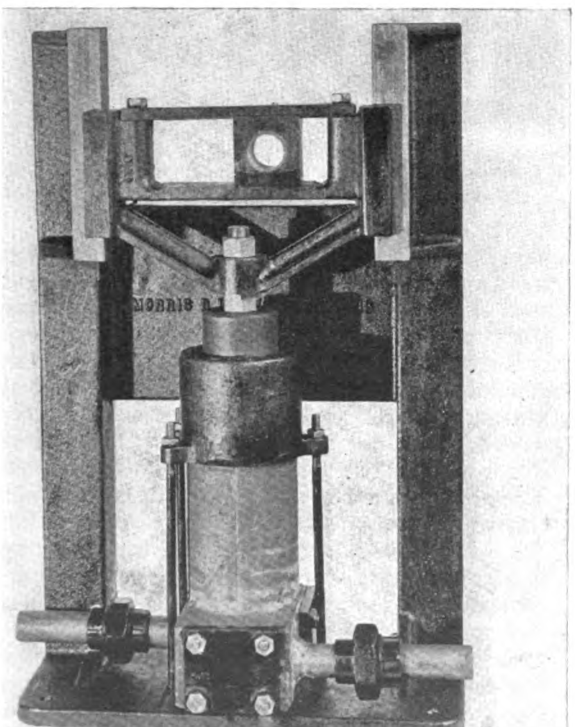
The third requirement—the use of double, or com-

posite clearance angles on the tool—was another feature of importance brought out. When rough grinding, the use of an angle 4 deg. greater than the finished angle desired was recommended. Finish grinding is then completed at the desired angle, grinding on the carbide tip only. By following this procedure no finish grinding on the steel shank is required, and the wheel remains open and free cutting for longer periods. This permits more rapid grinding and tends to produce a better finish.

The fourth requirement which was demonstrated is recommended for use when it is necessary to hog off large amounts of stock rapidly. The procedure outlined involves alternate grinding first on the steel shank, then on the carbide tip, continuing in this manner until the desired amount of stock is removed. Steel naturally loads silicon carbide wheels (made specifically for grinding carbides) more rapidly than ordinary wheels, whereas carbide tips tend to dress the wheels. By alternating first on the steel shanks and then on the carbide tip, more rapid grinding is possible. Of course ordinary aluminous oxide wheels can be used to grind on the steel shank when desired. However, in such cases, care must be used to avoid contacting the carbide tip. There are naturally other factors involved other than the four described above, such as use of proper wheels, correct machines, fixtures, etc. However, these four factors described above constitute the important features of the rapid technique demonstrated.

Reciprocating Acid Pump

A reciprocating acid pump recently placed on the market by the Morris B. Brewster Company, Chicago, is designed for circulating a solution of commercial muriatic acid through the closed-type of locomotive feedwater heater for removing the incrusting and heat insulating solid deposits on the heating surface from the boiler feedwater.



Close-up view of Brewster acid pump used in cleaning closed-type feedwater heaters

This pump is sturdy in construction and is said to have proved its durability in heavy duty service. At 100 2-in. strokes a minute, it is designed to circulate about 750 gal. of acid solution through the feedwater heater an hour, which is the average time required for thoroughly cleaning a heater.

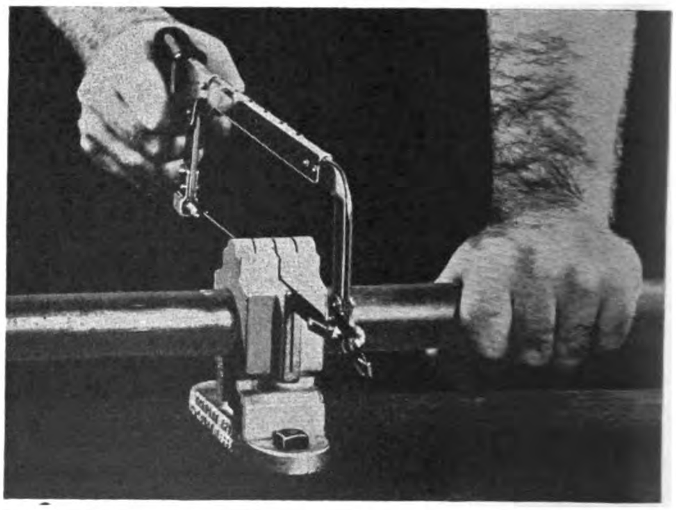
The pump is either electric- or air-motor driven and is constructed with acid resisting parts, such as a lead cylinder, hard rubber plungers and hard rubber check valves, with all other parts in contact with the acid being lead-protected and mounted on a suitable cast iron frame.

The entire assembly may be mounted, at the will of the purchaser, on a portable truck, which would carry with it the acid container from which the pump receives its supply of acid solution.

Sawing Vise Set

The Trimont Manufacturing Company, Roxbury, Mass., has developed a tool for holding, sizing and cutting thin wall copper and brass tubing by the use of which absolutely square cuts are obtained, thus insuring a perfect bearing of the tubing against the fitting shoulder. There is no chance for an imperfect wavy cut due to play in the saw because the saw blade is held closely in guides which bear against and all around the tubing while the cut is being made.

The tubing is sized and held to round while being cut in this sawing vise, making it easy to slip on the fittings; the tubing cannot be forced out of round no



Trimo sawing vise set for copper and brass tubing

matter how much pressure is put on the vise. An additional advantage is that when a piece of tubing has been forced out of line slightly so that it will not enter the fitting, the Trimo vise will bring it back to round sufficiently for the fitting to be slipped on. This means a saving of tubing which might otherwise have to be thrown away. There is also saving of material, due to the fact that both ends of the tubing are held from sagging and prevented from forming break-off burr or flat lip at the completion of a cut.

The Trimo sawing vise set is made in units of from ⅜ in. to 2 in. and is serviceable for welding, brazing or sweat-fitting jobs.

With the Car Foremen and Inspectors

Finding the Average Life Of Freight Car Wheels

*By F. R. Dorner**

Car and locomotive wheels represent an investment by railroads and private car companies in the United States of well over $200,000,000. The cost of maintaining this investment is a very important item of annual expense. Purchases of wheels, axles and tires by Class I railroads in 1935 amounted to $17,489,000, which, although below normal, represented the largest item of iron and steel purchased except rails. Moreover, this is only a part of the maintenance expense. The additional labor cost for mounting, dismounting, turning, etc., would be appreciable.

More than ever, owners of equipment are seeking ways and means of reducing wheel expense, and ultimately improving their operating ratio. They are especially interested in wheels under freight equipment where, due to the large number, the opportunity for savings is greatest.

Two factors determine wheel expense: one, prices; the other, service or life. Prices are easily secured. Records of service life on the other hand, are more difficult to obtain. Both must be available. There is no economy in a low-priced article which does not last. Neither is there economy in buying a higher priced article which does not last long enough to be worth its extra cost.

The difficulty in obtaining a dependable and accurate value for wheel life under freight equipment is due to the following:

1—A lack of understanding of how wheels wear out or fail.
2—Incomplete records of wheel applications, removals and mileages.

It is the purpose of this article to discuss these two factors in detail, and to propose a method of measuring wheel life which is dependable and accurate.

Individuals do not all live the same length of time. Some die in childhood, others die in old age. It is also true that in a group all of the same age, the number which die each year is not the same. In other words, in a group of 1,000 people about 200 would die before they reached ten years, but only 100 would die between the ages of 20 and 40. About 300 would die between the ages of 50 and 70. Insurance companies, of course, know quite accurately how many will die each year. They have available a table of experience covering the lives of people which, when plotted, is called a mortality curve. It is the fundamental basis of their insurance costs.

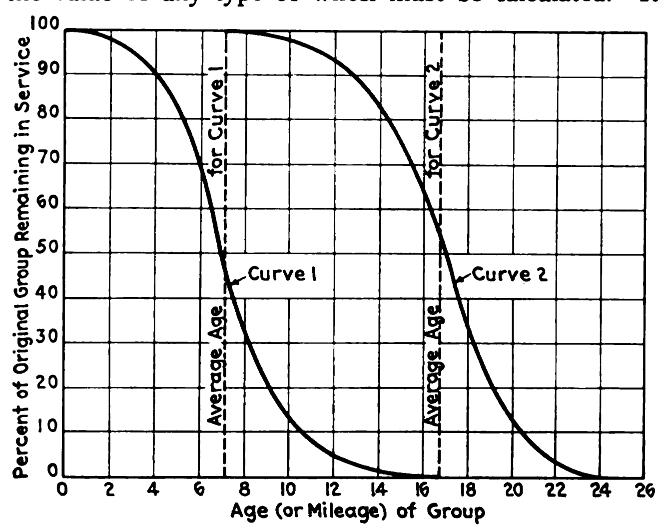
A mortality curve on which to base costs might be drawn for practically any physical structure. Two typical curves for freight-car wheels are shown in the accompanying chart. These curves will tell how the wheels wear out or fail. Along the vertical axis is shown the percentage of the original units installed, which are still in service. The horizontal axis shows the age, or mileage. Any point on the curve, therefore, expresses the percentage of the original units still in service after a certain number of years or miles.

Curve 1 is for a type of wheel which starts to fail at an early age. The rate of failure gradually increases and then becomes more or less constant along the straight part of the curve. In later years the rate becomes less and a few wheels last a very long time.

Curve 2 is for a type of wheel which is in service for some years before it begins to fail or wear out. Then it follows more or less the same shape as Curve 1 with a few wheels lasting many years.

All railroad men having to do with wheels will recognize these facts. They have seen wheels removed after only a very short period of service and they have also seen wheels which have shown an unusually long life. It is often a temptation to draw conclusions from either group, which are of interest but tell little about average life.

The average life is, of course, the figure on which the value of any type of wheel must be calculated. It



Mortality curves for two types of freight car wheels

is marked in the chart by vertical lines. If all the wheels reached the average age indicated and then were removed at one time the total mileage would be the same as the sum of the actual mileage for wheels removed according to the curve.

Recognizing the varying life of wheels, the only general and dependable method of finding average age or service is by establishing a mortality curve. Other methods have been used but are accurate only under specific conditions. Two of these will be presented.

Average age has been measured by dividing the number of wheels in service by the number replaced yearly. In the first place, purchases of wheels are often used instead of replacements. Thus, wheels replaced in interchange or removed from dismantled equipment are not included and the average life value may be high. Also, the wheels may not have been in use and the purchases for replacement may have been lower than normal. But the most important reason why this method is open to

* Armco Railroad Sales Co.

criticism is that it does not give an accurate value unless the wheels have been in service at least for their average life and in some cases at least two or three times their average life. In other words, if this method were used for wheels at a time when they were just beginning to wear out, the value for average life would be much too high. Another criticism is that the value would be correct only when applied to a group of wheels originally installed at the same time.

A second method for finding average life is based on measuring tread wear after a definite mileage but this method cannot be used for all types of wheels. What is desired is the actual but not the theoretical mileage to be received from the wheel. Unless it can be established that all wheels actually wear out, the method is valueless. Some wheels are replaced due to defects before having worn to the condemning limit. When using this method it is necessary to project the experience obtained over a short period into the future. This, if carried too far, is unsound.

If the mortality method is the only dependable one to use, how can the curve be found?

The simplest way to establish a mortality curve is to choose a test lot of a 100 wheels or more which are subjected to average service conditions.

If two types of wheels are to be tested, one type should be used in one truck of the car and the other type in the other truck. This eliminates any possibility of different service conditions. Preferably the equipment should be in a service where the wheels can be watched closely and the mileage determined with some degree of accuracy. On such a test lot a record should be made for each wheel removed of the mileage or length of time in service and the reason for removal.

This test might have to run a number of years in certain cases before all the wheels were removed. However, earlier approximations of average life can be made. By knowing the general shape of the mortality curve, an average life value might be obtained after 20 per cent of the wheels had been removed. Also, the total mileage or age when around half of the wheels had been removed would be close to the average life. For a type of wheel practically all of which eventually wear out and are not replaced because of defects, it is possible to estimate the remainder of the mortality curve by measurements of wear. The mortality curve is drawn to cover the actual removals as far as the test has progressed and the remainder of the curve is computed based on the extent of the wear and how long the remaining wheels would be expected to last. This can often be used for wheels having a comparatively long average life.

Another method can be used for finding the mortality curve which requires that records be kept for only a year or two. Groups of at least 20 wheels, each group representing a different age are chosen for the test lot, and a record made of the removals over a period of a year. For example, on January 1, 1936, the test lot would consist of 20 or more wheels installed during 1935, a similar number installed in 1934, about the same number installed in 1933, and so on. Then until January 1, 1937 a record would be kept of each wheel that was removed and the reason why it was removed. If desired, the record could be kept for another year to check the results of the first year. From these records the rate of removal could be found and the mortality curve determined for a period equal to the age of the oldest wheels. In analyzing such test results, the mortality curve method is the only one which will show whether the wheels have been in service long enough to obtain a value for average life.

It is apparent from the methods just described for finding the mortality curve that there are three essential facts that must be obtained from the records kept, that is

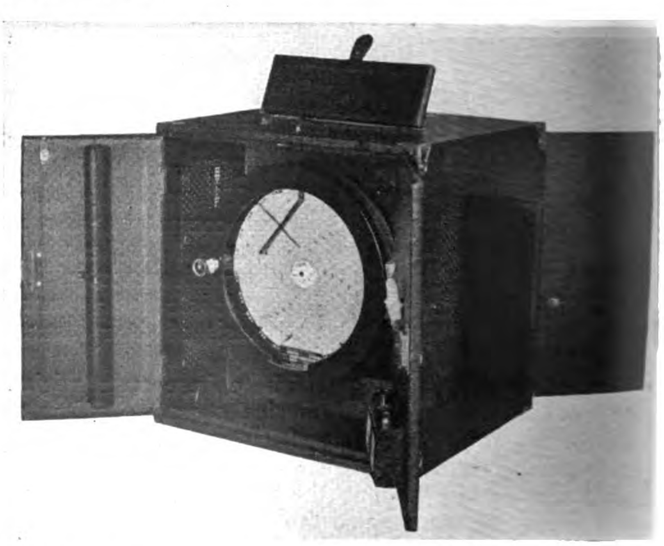
1—The mileage or time in service for every wheel removed.
2—The reason for removals.
3—The number of wheels which, after this mileage or time still remain in service.

Generally speaking, unless the records show this information, they cannot be used for finding average life. For example, the mere fact that 50 wheels had been removed after five years means nothing, unless the reason for removal and number remaining in service or the number originally started with is known. The average life would be very different if in one case the original lot consisted of 100 wheels and in the other case consisted of 5,000 wheels. It is just as absurd to average the age of the first removals and call this the average life. In this case also, no consideration has been given to the cause of removal or to the number of wheels still remaining in service. The number of removals must always be considered with relation to the total number of wheels in service of the same age. The reason for removal will enable proper consideration to be given to withdrawals for causes not attributed to wheels, such as cut journals.

The large investment in wheels and the annual maintenance cost warrants more specific information on wheel life than is generally available. The application of the mortality curve presents a simple, accurate and dependable method for determining average life.

Air-Conditioning Road And Laboratory Tests

To conserve an investment in air-conditioning equipment, estimated to have amounted to about forty million dollars since 1932, and to increase the effectiveness of future expenditures in this field, the Association of American Railroads has authorized an extensive study of air conditioning in passenger cars. This study is to be made under the direction of L. W. Wallace, director of equipment research of the A.A.R., and, as the first step, a manual outlining the purpose of the program and schedules of the study has been prepared. A comprehensive report is promised by November, at which time air-conditioning programs for 1937 will be under consideration.



Air-conditioning engineer's compact test kit as equipped with Brown temperature and humidity recorder

The principal objectives of the investigation, as summarized in the manual, are: (1) to determine the basic ractices and policies which should be adopted with espect to air-conditioning railroad passenger cars; and 2) to determine what system or systems are most uitable for railway service as measured in terms of (a) apital investment, (b) cost of maintenance and operaion, and (c) satisfaction and well being of passengers.

Involved in such determinations are design, perormance and cost problems. To obtain basic and reiable information relating to these matters, two types of nvestigations are necessary; namely, road and laboraory. The work has been so planned that the results of the road and laboratory work supplement each other, thereby making it possible to secure an objective picture of existing conditions and what may be done to improve them.

It is essential that factual information be secured with reference to many aspects of the air-conditioning systems now being used by the railroads. These may be classified under three headings, namely: (A) Mechanical, design and performance; (B) investment, operating and maintenance costs; and (C) results obtained as regards temperature, humidity, distribution, quality, cleanliness of air, and odors.

In order to obtain the necessary information covered by (A) and (C), the following specific data is to be secured:

(1) Method of controlling temperature and humidity in cold and warm weather and with what results. This eventually will involve establishing a standard temperature and relative humidity relationship for various sections of the country and a temperature differential with respect to outside conditions.

(2) The type of air filters used and the results being obtained; the directions in which improvements may be made so as to secure more satisfactory results.

(3) The amount of power being used per unit of work done (which is power per ton of refrigeration).

(4) Means used in securing diffusion of air within the cars that are materially different from common practice.

(5) The difficulties, if any, in installing, operating and repairing the power plant for air-conditioning.

(6) The facilities for servicing equipment in the yards.

(7) The experience had with odors and what means have been adopted to lessen this problem and with what success.

(8) Difficulties experienced in making inspections and repairs.

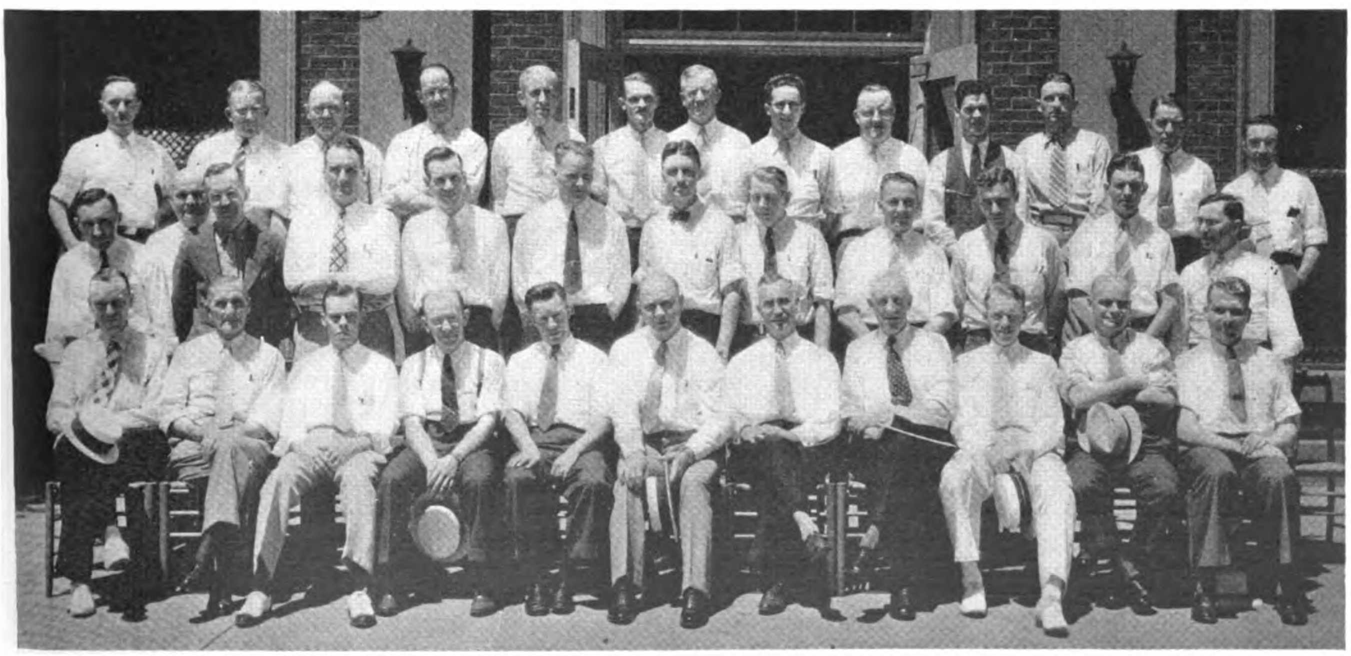
(9) Time required to inspect, repair and replace the the various units of the several air-conditioning systems.

(10) Determine actual results being obtained in air conditioned cars with respect to temperature, humidity, cleanliness, odors, air movement and distribution of air.

Work Already in Progress

Through the courtesy of the Baltimore & Ohio, facilities have been made available at the Mt. Clare shops, Baltimore, Maryland, for making laboratory tests of each type of air conditioning being used on railroad passenger cars. Through the generous and interested co-operation of the manufacturers, their respective equipment is being sent to Baltimore for test. The test work began there March 15. To date six systems have been thoroughly tested. This phase of the work will be completed in August. The equipment is being tested in accordance with the standard method of rating and testing air-conditioning equipment, as prepared by the Joint Committee on Rating Commercial Refrigerating Equipment from the American Society of Refrigerating Engineers and the American Society of Heating and Ventilating Engineers.

The object of these tests is to compare the performance of each system as a whole and also that of each major element of the several systems: compressors, condensers and evaporators. The amount of power required per unit of cooling effect produced will be determined also. It is recognized that the amount of power consumed in the operation of an air conditioning system is of great importance. Therefore, the character and efficiency of the type of drive or prime mover is to receive careful study. For this purpose a special program for the testing of the several types of drives used is to be conducted at Ohio State University. This program started early in June and will be completed in August. By correlating the data secured in the tests of the com-

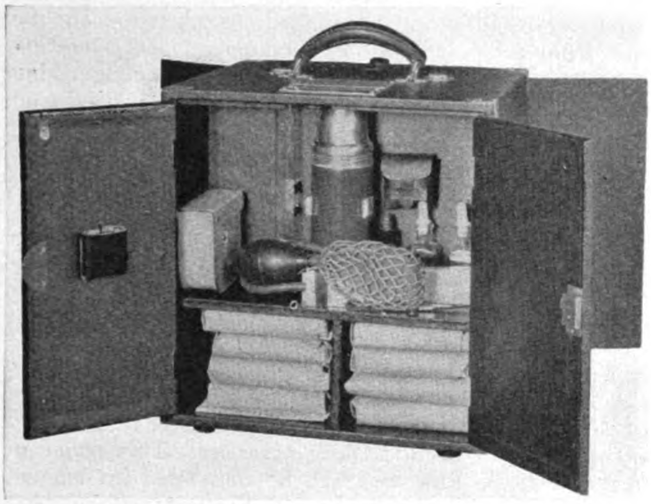


Railway air-conditioning engineers at five-day conference held at Ohio State University, Columbus, Ohio, July 6 to 10, inclusive

pressor, condenser and evaporator at Baltimore, the relationships between the cooling effect produced and the power delivered into the system will be determined.

The Pullman-Standard Car Manufacturing Company has provided facilities at Pullman for the testing of four cars at one time. About 15 cars have been tested. The test program comprehends hot-room tests of air-conditioned cars conducted for the purpose of determining the cooling load required when all factors of loading are present, as in road service, except those caused by solar radiation and wind effect. A second objective is the determination of the effectiveness of the insulation of the car. Further objectives (not previously stated) are a study of the air and temperature distribution within the car; the determination of the amounts of fresh and recirculated air supplied for various settings of the fresh-air damper; and the determination of the comparative temperatures occurring within the car when heated and humidified as it would be when occupied to full capacity.

These tests, completed in July, were made on the following types of cars, as operated by various railroads



Rear view of the opened test kit showing some of the auxiliary equipment used for various test purposes

and equipped with each type of air-conditioning system tested at Baltimore: coach, lounge, diner, combination, sleeper and cafe. The results of these tests will supplement those obtained at Baltimore.

Road Tests to Include Study of Public Reactions

During the latter part of July and August an extensive road testing program will be conducted simultaneously on railroads throughout the country in order to accumulate a large amount of data covering the performance and efficiency of the various systems in all kinds of cars and under all kinds of different operating conditions. Provision has been made, however, for taking temperature and other readings with identical equipment and in the same manner so that the results will be directly comparable.

For the purpose of outlining this program of tests, a five-day conference has just been concluded at Ohio State University, Columbus, Ohio, attended by 31 air-conditioning engineers representing the following railroads: Atchison, Topeka & Santa Fe, Atlantic Coast Line, Baltimore & Ohio, Boston & Maine, Maine Central, Canadian Pacific, Central of Georgia, Chicago & Eastern Illinois, Chesapeake & Ohio, Chicago & North Western, Chicago, Burlington & Quincy, Chicago, Milwaukee, St. Paul & Pacific, Chicago, Rock Island & Pacific, Delaware, Lackawanna & Western, Florida East Coast, Great Northern, Illinois Central, Lehigh Valley, Louisville & Nashville, Missouri Pacific Lines, New York Central, New York, New Haven & Hartford, Northern Pacific, Pennsylvania, Reading, St. Louis-San Francisco, Seaboard Air Line, Southern Pacific and the Wabash.

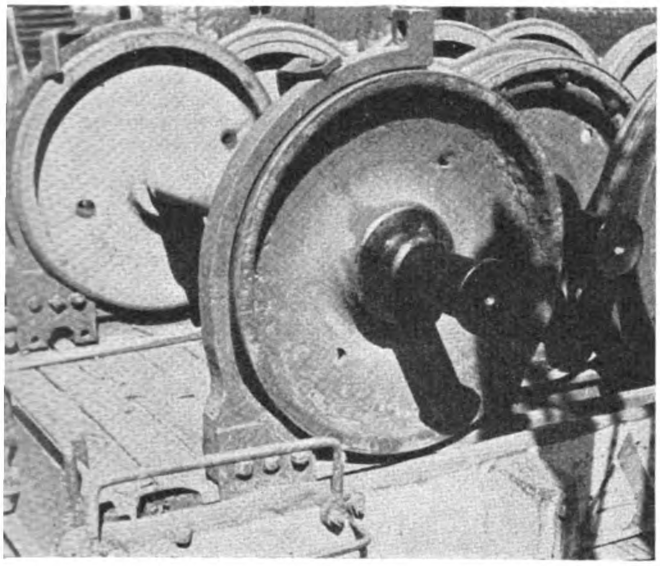
According to the program, about 400 air-conditioned and non-air-conditioned cars will be ridden for test purposes during the next few weeks. Each engineer will ride cars of different types in specified trains on his own line and be equipped with a kit of instruments for the purpose of making necessary measurements. As shown in the illustrations, this kit consists of the following equipment: Brown temperature and humidity recorder, Kata thermometer for examining air velocity, psychrometer for obtaining humidity, anemometer to determine fresh and recirculated air used, Wolpert's air tester to determine the amount of CO_2 in the air, culture plates to determine the bacteria colonies, thermometers to determine outside temperatures, stop watch and accessories, such as thermos bottles, steel measuring tape, pliers, etc.

In connection with these road tests, a questionnaire has been prepared which will be distributed to passengers by the research engineers. In that questionnaire, inquiry will be made as to whether, in the opinion of the passenger, the car or train is too warm or too cool; if it is "clammy," stuffy, drafty or noisy, or possibly too cool upon entering. Passengers will also be asked whether there are any objectionable odors, evidence of smoke when passing through tunnels, excessive tobacco smoke, and, if occupying a berth in a sleeping car, whether it is too warm or too cool or is sufficiently ventilated. If the air-conditioning is or is not entirely satisfactory the passenger is going to have an opportunity to express himself to such extent as he sees fit. These questionnaires will be collected by the research engineers and the answers carefully tabulated.

Every important phase of the air conditioning of passenger cars is covered in the program of road and laboratory tests which has been developed. As a consequence, the test results promise to be comprehensive and generally beneficial both to railroads and to manufacturers of air-conditioning equipment. It is felt that, with these test results available, railroads can proceed with their air-conditioning programs with much more assurance as to costs and as to the conditions actually obtained in passenger cars.

Loading Car Wheels For Shipment

The method illustrated provides a safe and quick method of loading car wheels on flat cars for shipments between the central wheel shop or stores department and various car repair points, or scrap disposal yards on a railroad. The method consists simply of spiking four rails to the floor of a flat car so spaced that the wheels will be "nested" in accordance with the usual manner. A forged steel clamp is bolted to each end of one pair of rails, this clamp providing a substantial wedge stop at the bottom of the wheel and having the upper part of the clamp forged in a segment to fit approximately 120 deg. of the wheel tread. This clamp is held on the tread of the wheel and against the flange by means of a swinging steel angle strap. The upper end of each clamp is forged to a substantial rectangular shape which can be drilled for the application of a 1-in. tie rod and double nut, this rod extending the length of the car so



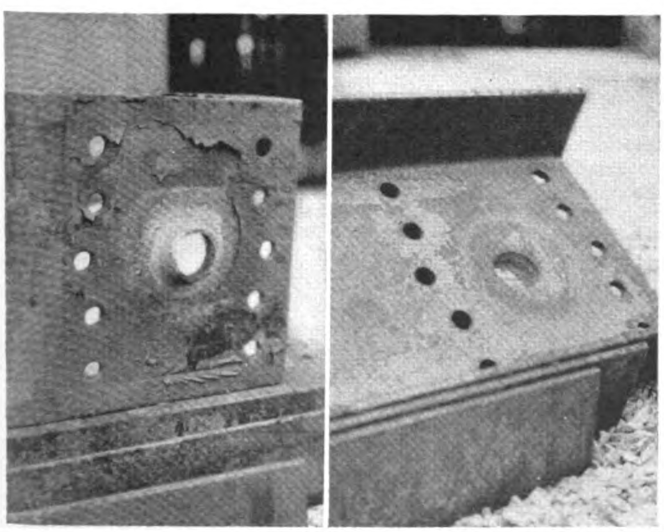
Safe and relatively inexpensive method of loading wheels on a flat car

that when tightened it holds the wheels rigidly against shifting. Experience has shown this method of loading car wheels to be cheaper and quicker than spiking wooden wedges to the floor to hold each pair of wheels.

Reclaiming Spring Plank From Arch Bar Trucks

Because of the outlawing of arch bar type freight car trucks after January 1, 1938 most of the railroads have arranged to remove them from cars on a monthly schedule which provides for the application of cast steel side truck frames to all such cars which are to be used in interchange service after that date.

To reduce the cost of this project it is desirable to make use of as many parts from the arch bar trucks as possible. Truck bolsters, both cast steel, Simplex and other built-up types are interchangeable and the brake beams, brake hangers, brake levers, pins, etc., can be reclaimed and used on the cast steel side frame truck. However some difficulty has been experienced in reclaiming 13-in. spring plank channels due to the lack of facilities for riveting or otherwise securing the channel type spring plank to the cast steel truck sides having the journal boxes cast integral.



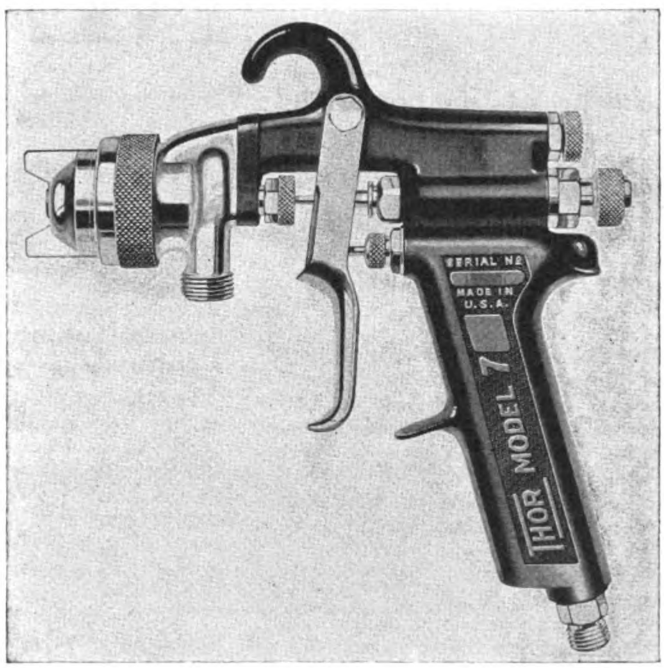
These two views show both sides of the channel after punching

The two illustrations will show the method employed by one railroad in reclaiming the spring plank channels. A one-inch hole is punched in the center of the spring plank channel and the surface for a distance of five inches around the hole is heated. A set of dies, which can either be attached to a steam hammer or to some pneumatic device are used to punch through the heated area on the top surface of the channel which will provide a one-inch lip on the base. This will permit the lip of the opening to set down in the base of the cast steel truck frame, and when the truck springs and bolster is applied no other provision for securing the channel to the truck side is necessary.

Production Spray Gun

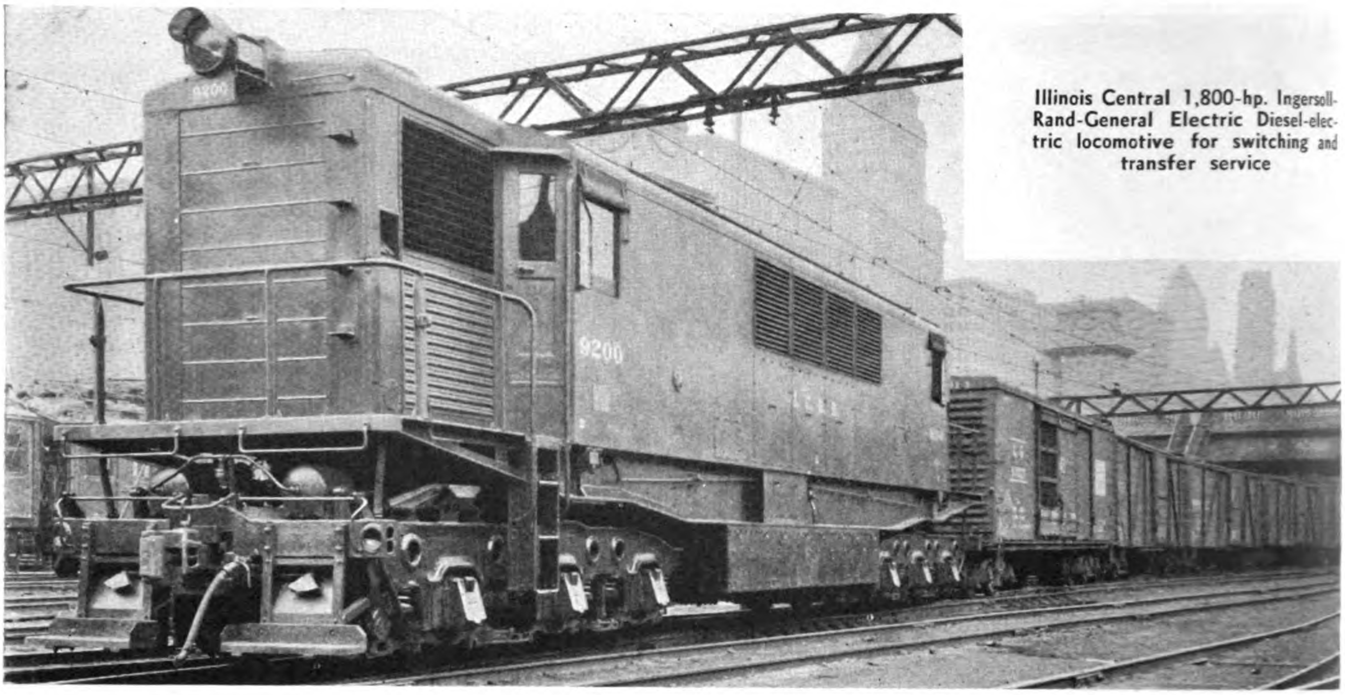
Great speed, low air consumption and perfect atomization are claimed for the new Thor Model 7 spray gun made by the Binks Manufacturing Company, 3114 Carroll avenue, Chicago.

The Thor Model 7 gun has incorporated in it a number of good points suggested by users of the spray painting process. The gun body is of durable drop-forged aluminum with a black electrolytic coating for surface protection. The air nozzle is of drop-forged bronze, chromium plated. The material nozzle and the nozzle valve are of stainless steel, hardened and polished. The adjustments are ample and well located. The fluid connection is of ⅜-in. pipe size and the air connection ¼-in. pipe.



Thor Model 7 paint spray gun

STREAMLINED NICKNAMES—It was inevitable that the railroaders with their genius for nicknames should rechristen some of the new fast trains. The "Zephyr" has become the "Zipper" and, along the Milwaukee, the "Hiawatha" is known as the "Highwater."



Illinois Central 1,800-hp. Ingersoll-Rand-General Electric Diesel-electric locomotive for switching and transfer service

NEWS

Fire at Rock Island Enginehouse

THE enginehouse of the Chicago, Rock Island & Pacific, at St. Joseph, Ill., was damaged by fire on July 5 to an estimated extent of $200,000, including damage to three locomotives and the machine shops.

U.P. Creates Department of Research

THE Union Pacific has established a bureau of research, with O. Jabelmann, assistant general superintendent of motive power and machinery, with headquarters at Omaha, Neb., as its head. Men now engaged in research work have been assigned to the new bureau, and mechanical, electrical and metallurgical experts will be added. The bureau will study, survey and perfect improvements in design and construction of cars and locomotives.

A photograph and brief sketch of Mr. Jabelmann's career appear on page 373 of this issue.

S. W. Dudley Nominated Manager of A.S.M.E.

S. W. DUDLEY, recently appointed dean of the Yale School of Engineering, Yale University, New Haven, Conn., is among the A.S.M.E. nominees for the year 1937. Dean Dudley, together with E. W. Burbank, manager, Allis Chalmers Mfg. Co., Dallas, Tex., and Kenneth H. Condit, editor, American Machinist, New York, has been nominated to serve as a manager of the Society. The presidential nominee is James H. Herron, president of the James H. Herron Company, Cleveland, Ohio, and those for vice presidents are J. A. Hall, professor mechanical engineering, Brown University, Providence, R. I.; J. M. Todd, consulting engineer, New Orleans, La.; R. J. S. Pigott, staff engineer, in charge of engineering, Gulf Research & Development Corporation, Pittsburgh, Pa.

At the semi-annual meeting held at Dallas, Tex., June 15-20, it was also voted to hold the 1937 semi-annual meeting at Detroit, Mich.

Eastern Committee Appointed to Continue Co-ordination Studies

THE Eastern Presidents' Conference at its July 16 meeting appointed a committee to take up the unfinished work of the Eastern Regional Co-ordinating Committee in connection with co-ordination projects concerning which no definite action had been taken at the expiration of Interstate Commerce Commissioner Eastman's term as federal co-ordinator of transportation.

The appointment of this committee, the announcement says, is in accordance with a request of the Association of American Railroads, which asked Eastern, Western and Southern regional organizations to arrange for carrying forward studies which had been considered by the regional co-ordinating committees on behalf of the federal co-ordinator, as well as "such other projects as might from time to time be presented, having in view economies in operation through co-ordination of services of facilities."

Public Asked to Express Views on Air-Conditioning

THE traveling public for the next few months is to be asked to submit its views on the efficiency of the air-conditioning equipment now in use on passenger trains throughout this country, J. J. Pelley, president of the Association of American Railroads, has announced.

This is to be done in connection with the exhaustive research now being conducted by the Equipment Research Division of the Association of American Railroads in order to determine how well the various air-conditioning devices in use on passenger cars function under varying climatic and operating conditions, what might be done to improve their performance, and what standardization of such equipment can be developed in order to reduce costs of operation and maintenance.

Air conditioning engineers from 30 of the leading railroads have for the past few weeks been engaged in an intensive study of that subject at Ohio State University and elsewhere and, beginning this week, they will conduct a series of tests on trains throughout the United States in order to secure data as to the results being obtained from air conditioning of passenger cars.

In connection with those tests, there has been prepared a questionnaire which will be distributed to passengers by the research engineers. In that questionnaire, inquiry will be made as to whether, in the opinion of the passenger, the car or train is too warm or too cool; if it is "clammy," stuffy, drafty or noisy, or possibly too cool upon entering. Passengers will also be asked whether there are any objectionable odors, evidence of smoke when passing through the tunnels, excessive tobacco smoke, and, if occupying a berth in a sleeping car, whether it is too warm or too cool or is sufficiently ventilated. These questionnaires will be col-

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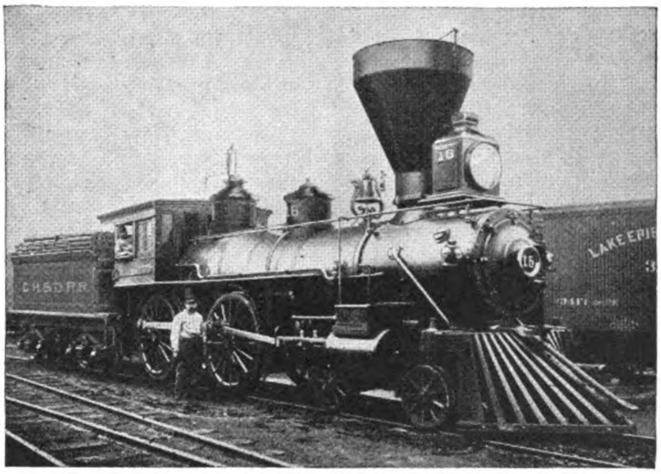
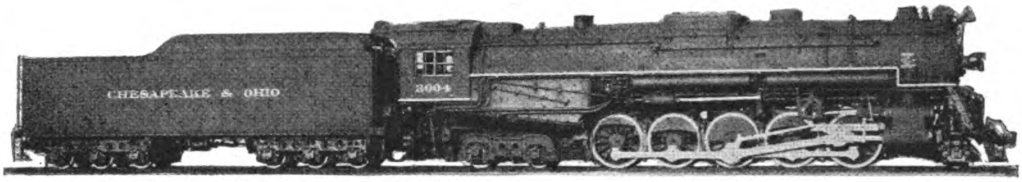
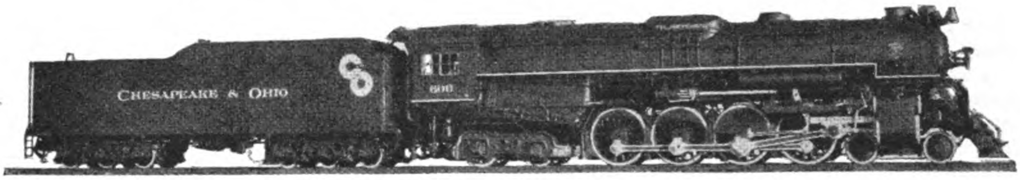


MOTIVE POWER DEVELOPMENT on the C. & O.

Just one generation ago wood burning 4-4-0 type locomotives like that shown above were hauling thru fast trains over lines now part of the C. & O. At that time this power was the foremost of locomotive developments.



Continuously maintaining its position among the leaders in locomotive progress the C. & O. in 1930 placed in service the large freight power shown above.



The latest additions to its modern equipment are the Greenbrier Type locomotives which the C. & O. placed in service in January of this year. In results obtained in improved operating efficiency and economy, this new power reflects the ability and progressive foresight of the management.

LIMA LOCOMOTIVE WORKS INCORPORATED, LIMA, OHIO

LIMA LOCOMOTIVE WORKS INCORPORATED

lected by the research engineers and the answers carefully tabulated. At the same time the answers will be compared with the analysis of air-conditions shown to have existed through scientific tests in that particular car or train on that day.

In order to make these tests, the research engineers have been equipped with small, especially designed kits about the size of an ordinary handbag, containing the most delicate and sensitive instruments that have yet been devised for this purpose. These instruments, among other things, will record and measure the slightest draft, one which can not be felt by the ordinary person; chart the humidity and temperature as they may vary in the car over a 24-hour period; detect the remotest trace of carbon dioxide in the car as well as count the bacteria in the air. Another will calculate the actual refrigeration, while still another will show the effect of the rays of the sun through the windows and against the curtains of the car.

The course of special study which these research engineers have been undergoing at Ohio State University has covered all phases of air-conditioning. It has been conducted by L. W. Wallace, Director of the Equipment Research of the Association of American Railroads, and by Professor A. I. Brown, of the Engineering School of that University, who is serving as a special consultant in this matter.

At the same time these road tests are being made a series of experiments by the Research Equipment Division as to air conditioning of passenger cars will be under way at Ohio State University, the Mt. Clare Shops of the Baltimore & Ohio, at Baltimore, and the Pullman-Standard Car & Manufacturing plant in Chicago. In those experiments, various types of air conditioning equipment will be put through exhaustive tests in order to ascertain what improvements can be made so as to insure the maintenance of proper temperatures under varying climatic conditions in passenger cars.

Railroads Ask I.C.C. to Dismiss Power Reverse Gear Case

Safety to employees and the public would not be increased by compelling the railroads to install power reverse gear on virtually all locomotives, and the only result would be to place a heavier financial burden on the rail carriers at a time when they can least afford it, according to a brief filed by the Association of American Railroads asking the Interstate Commerce Commission to dismiss proceedings brought by the Brotherhood of Locomotive Engineers, and the Brotherhood of Locomotive Firemen and Enginemen to require the installation of power reverse gears as a substitute for hand operated gears.

Such an order, if promulgated by the commission, would require the installation of power reverse gears on more than 18,000 locomotives at a cost in excess of $7,000,000, according to the brief. Replying to contentions of the complainants that power reverse gears would bring about increased safety in the operation of locomotives, the brief said:

"Accidents to men in the locomotive cab involving movements of the lever are more common with hand gears than with power gears but such accidents are seldom severe and are, with negligible exceptions, if any, not the result of any fault or quality which can be remedied only by elimination of the hand gear. On the other hand, accidents to men working around locomotives, due to movements of the reverse gears, and accidents due to locomotives running into roundhouse walls and turntable pits, are more common with locomotives equipped with power gears. These accidents are often serious and are largely due to characteristics inherent in the power gear, that is: to the relatively great force which impels the moving parts of the gear; to the unexpected movements of the gear or engine caused by 'creeping' or 'settling' as a result of which the position of the lever in the cab does not correspond with the position of the valve gear; to the inability of the operator of the lever to feel an obstruction in the event a man is caught in the moving parts of the gear; to the inability to stop promptly the movement of the gear by operating the lever in the cab; and to the fact that a power reverse gear cannot be utilized as a braking device in the absence of suitable air pressure. None of these faults or disabilities is encountered with hand gears.

"Virtually all railroad expenditures have a direct bearing upon safety," the brief continued. "Every feature of railroad operation is related to safety and over-emphasis on one feature, with the resulting under-emphasis on others, is bound to affect adversely, rather than to promote, the safety of railroad operation as a whole. Thus, the installation of power gears should not be required unless the commission should find that it would serve an unmistakable and important purpose in promoting safety. The record furnishes no possible basis for such a finding. On the contrary, it clearly shows that considerations of safety are not involved."

This is the second time that this matter has been considered by the Interstate Commerce Commission. In 1930 the organizations of locomotive engineers and firemen instituted proceedings to have power reverse gears installed on all steam locomotives on the ground that the manually operated gears constituted an unnecessary peril to life and limb. The commission issued an order requiring this to be done, but a three-judge federal district court in Cleveland enjoined the commission from enforcing the order on the ground that it was arbitrary and that the commission had failed to consider fairly all of the pertinent and substantial facts. The United States Supreme Court affirmed the order of the lower court. In March, 1935, the engineers and firemen petitioned the commission to reopen the proceedings and to have further hearings. This petition was granted and the commission recently concluded hearings in the case.

Historical Society Trip Marks Morris & Essex Centennial

A Camel-back ten-wheeler built in 1910 returned temporarily to main-line service on the Delaware, Lackawanna & Western on Sunday, July 19, when it drew a special train containing a party organized by the New York Chapter of the Railway and Locomotive Historical Society from Hoboken, N. J., to Scranton, Pa. The trip marked the centennial of the Morris & Essex, now the route of the Lackawanna across New Jersey.

The locomotive was resplendent with new paint and burnished fittings and it further belied its age by pulling the train up a slight grade of 28 mi. in 26 min., according to the timing of the historians. It was equipped with the Wooten wide firebox designed for anthracite and had separate cabs for the engineman and fireman. It was built at the Schenectady works of the American Locomotive Company.

The combination baggage car used was about the same age as the locomotive but the following dining car and three coaches were the latest air-conditioned types.

(Continued on next left-hand page)

New Equipment

Locomotive Orders

Road	No. of locomotives	Type of locomotive	Builder
P. & W. V.	2	2-6-6-4	Baldwin Locomotive Works
R. F. & P.	5	4-8-4	Baldwin Locomotive Works
Union Pacific	1	3,600-hp. Diesel-elec.	Electro-Motive Corp.

Locomotive Inquiries

Road	No. of locomotives	Type of locomotive	Builder
Monessen Southwestern	1	0-6-0	....

Freight Car Orders

Road	No. of cars	Type of car	Builder
A. T. & S. F.	10	Covered hopper	American Car & Foundry Co.
Aluminum Ore Co.	50	70-ton covered hopper	Pullman-Standard Car Mfg. Co.
American Refrigerator Transit Co.	510	40-ton refrigerator	American Car & Foundry Co.
	510	40-ton refrigerator	General American Trans. Co.
Cambria & Indiana	300	50-ton hopper	American Car & Foundry Co.
Central of Georgia	200*	Hopper	Pullman-Standard Car Mfg. Co.
Minneapolis & St. Louis	60	Gondola	General American Trans. Co.
M. St. P. & S. S. M.	500	Box	Pullman-Standard Car Mfg. Co.
Newfoundland Ry.	50†	30-ton box	Koppel Indus. Car & Equip. Co.
Norfolk & Western	800	40-ft. box	Ralston Steel Car Co.
	100	Auto., with loaders	Magor Car Corp.
	100	50-ft. box	Greenville Steel Car Co.
St. Louis Southwestern	50	Automobile	General American Trans. Co.
Wisconsin Central	250*	Box	Pullman-Standard Car Mfg. Co.
Western Maryland	25	Caboose	Company shops

Freight-Car Inquiries

Road	No. of cars	Type of car	Builder
Kennecott Copper Corp.	50	100-ton ore	....
Lehigh & New England	6	Caboose	....

Passenger-Car Orders

Road	No. of cars	Type of car	Builder
Seaboard Air Line	6	Coaches	Pullman-Standard Car Mfg. Co.
	4	Comb. pass.-bagg.	Pullman-Standard Car Mfg. Co.
T. & N. O.	5‡	First-class coaches	National Steel Car Corp., Ltd.
	4	Comb. bagg.-coach	National Steel Car Corp., Ltd.

* Subject to approval by the Court.
† 42-in. gage.
‡ To be air-conditioned.

Supply Trade Notes

The R and C Company, 1218 Olive street, St. Louis, Mo., has been appointed to represent in that region the Graham-White Sander Corporation, Roanoke, Va.

L. K. Sillcox, vice-president of the New York Air Brake Company, has been appointed first vice-president, and K. E. Keiling, assistant to president, has been appointed vice-president and sales manager.

The Standard Stoker Company, Inc., has reorganized its engineering staff with headquarters at Erie, Pa., as follows: C. R. Davison is now mechanical engineer and E. F. Seibel is chief draftsman. This department was formerly headed by the late H. P. Anderson, chief engineer.

The Globe Steel Tubes Co., Milwaukee, Wis., has opened a new sales office at 1478 Starks building, Louisville, Ky., in charge of W. H. Buley, former sales supervisor at Milwaukee. C. J. Bickler, sales engineer at Milwaukee, has been appointed manager of sales of the Cleveland district, with office in the Terminal Tower building, Cleveland, Ohio. C. D. Haven, formerly connected with the Chicago office, is associated with Mr. Bickler.

Wallace W. Smith, assistant to the vice-president in charge of sales of shapes, plates and steel piling, of the Inland Steel Company, Chicago, has been promoted to assistant vice-president in charge of the sale of structural shapes, plates, floor plates and steel sheet piling, and Maurice E. O'Brien, sales representative, has been promoted to manager of sales, carbon steel bars and billets, and will also have charge of sales to manufacturers of agricultural implements.

E. I. Hetsch, formerly assistant to chief mechanical engineer of the Nathan Manufacturing Company, has been appointed sales engineer of the Q & C Company, with headquarters at 90 West street, New York. Mr. Hetsch was educated at John Hopkins University and is a graduate of the Institute of Machine Design at Karlsruhe, Germany. He entered railroad service in 1920 with the Chesapeake & Ohio and after serving in various capacities was assigned to special work in a study of locomotive lubrication.

Paul C. Cady, formerly of the engineering department of the New York Central, has been elected vice-president in charge of sales for the Eastern district for the Union Railway Equipment Company, Chicago, with headquarters at 30 Church street, New York, and B. C. Tucker, formerly of the Midland Railway Supply Company, has been appointed sales representative in charge of special work, with headquarters in the Midland Building, Cleveland, Ohio.

The Colorado Fuel & Iron Corporation, a newly formed organization, has taken over the assets of the Colorado Fuel & Iron Company, under a court order of Federal Judge J. Foster Symes. The Colorado Fuel & Iron Company had been in the hands of a receiver and trustee since August, 1933, the approval of its reorganization plan was confirmed by formal court order on April 26. The officers of the new corporation are: Arthur Roeder, president; S. G. Pierson, vice-president and treasurer; W. A. Maxwell, Jr., N. H. Orr, and Thomas Aurelius, vice-presidents; D. C. McGrew, secretary; H. C. Crout, assistant treasurer; Harry P. Fish, assistant secretary; Terrell C. Drinkwater, assistant secretary; Fred Farrar, general counsel; W. B. Montgomery, controller; and J. A. Bullington, assistant controller.

F. H. Hardin, assistant to the president of the New York Central, has resigned to accept the position of president of the Association of Manufacturers of Chilled Car Wheels on September 1. He will succeed J. A. Kilpatrick, who will devote his time to private interests.

The Milcor Steel Company, Milwaukee, Wis., has been consolidated with The Inland Steel Company, Chicago, effective July 1, following the purchase of all of the outstanding stock of the Milcor Company for 59,000 shares of the capital stock of Inland. No changes will be made in the management or operations of the Milcor Company. The present officers will continue to operate the company as a unit. The Milcor Company, manufacturers of sheet metal building products, has plants at Milwaukee and Canton, Ohio, and warehouses at Chicago, Kansas City, Mo., and LaCrosse, Wis.

Obituary

George Sykes, assistant to the president of the Baldwin Locomotive Works, died in Media (Pa.) Hospital on July 10, from injuries received the previous day when he was thrown from the back of his horse. Mr. Sykes was born in Yorkshire, England, and was 48 years old at the time of his death.

Clayton Mark, president of Clayton Mark and Company, Chicago, and a director of the National Malleable and Steel Castings Company, and the Interlake Iron Company, died in Lake Forest, Ill., on July 7 after a month's illness. Mr. Mark was born in Fredericksburg, Pa., in June, 1858, and in 1876 entered the employ of the Chicago Malleable Iron Company as a clerk. When this company was succeeded by the National Malleable and Steel Castings Company he continued in its employ, being a director until 1894, a second vice-president until 1902, and a resident vice-president until 1917. In 1902 he organized the Mark Manufacturing Company, of which he was president until 1919, when the company was merged into the Steel and Tube Company of America, of which he became chairman of the board. He retained the latter position until this company was sold to the Youngstown Sheet and Tube Company in 1923, at which time he organized Clayton Mark and Company of which he was president at the time of his death.

John Gilmore Platt, president of the Hunt-Spiller Manufacturing Corporation, Boston, Mass., was drowned Sunday, July 26, in Long Pond, near his summer home at East Harwich on Cape Cod, his motor boat being capsized by the wind. Mrs. Platt and their daughter, Mary, were rescued.

Mr. Platt joined the Hunt-Spiller Manufacturing Corporation in 1907 as mechanical representative. He was made sales manager in 1912, was elected vice-president in 1917, and has been president of the corporation since 1928. He was born in Zanesville, Ohio, February 11, 1874, and attended the public schools of Baltimore, Md. He entered the service of the Baltimore & Ohio in 1889 as a messenger, and a year later became an apprentice in the locomotive department. In 1894 he was made a locomotive draftsman and in 1901 became chief draftsman at Newark, Ohio. He went with the Erie Railroad at Jersey City, N. J., in 1902, as assistant to

John G. Platt

the master mechanic, and in 1903 was transferred to Meadville, Pa., as engineer of tests. In 1907 he left railroad service and became master mechanic of the Franklin Branch of the American Steel Foundries, leaving that position in the same year to go with the Hunt-Spiller Manufacturing Corporation.

Mr. Platt always took a keen interest in the Railway Supply Manufacturers' Association and was a member of its executive committee from 1916 to 1920, and chairman of its exhibit committee in 1920. He has also been a member of the governing board of the Railway Business Association, and a member of the finance committee of the New England Railroad Club. He was a director of the Brighton Savings Bank and a member of the Engineers Club of Boston.

Personal Mention

General

F. H. HARDIN, assistant to the president of the New York Central, has resigned to accept the position of president of the Association of Manufacturers of Chilled Car Wheels on September 1.

J. F. LEIGHTIZER, master mechanic of the Island Division of the Canadian National, has been appointed assistant superintendent and master mechanic, Island Division, with headquarters at Charlottetown, P.E.I.

L. D. RICHARDS, superintendent of motive power of the Chicago, Rock Island & Pacific at Kansas City, Mo., has been appointed district superintendent of motive power, with jurisdiction in mechanical matters and with headquarters at El Reno, Okla.

PHILIP J. NORTON, district superintendent of motive power and machinery of the Union Pacific at Pocatello, Idaho, has been appointed assistant general superintendent of motive power and machinery, with jurisdiction over the locomotive and car departments of the Central, Northwestern and Southwestern districts, with headquarters at Pocatello. The promotion is coincident with the assignment of Otto Jabelmann to head the Union Pacific's new research bureau.

STANLEY M. HOUSTON, superintendent of motive power of the Southern Pacific of Mexico at Empalme, Son., Mexico, has been appointed assistant general manager of the Southern Pacific of Mexico, with headquarters at Guadalajara. Mr. Houston was born on June 5, 1898, at Albuquerque, N. M., and entered railway service on March 30, 1913, as a machinist apprentice with the Arizona Eastern at Globe, Ariz. On April 1, 1917, he was promoted to machinist, and on March 1, 1919, to roundhouse foreman. From March, 1922, to March, 1923, he was general foreman, and from the latter date to October, 1924, master mechanic. In October, 1924, he resigned to become superintendent of shops of the Southern Pacific of Mexico, which position he held until July, 1927, when he became superintendent of motive power.

Stanley M. Houston

OTTO JABELMANN, assistant general superintendent of motive power and machinery of the Union Pacific, with headquarters at Omaha, Neb., who heads the newly-established research bureau of this company, was born in Cheyenne, Wyo., and started service with the Union Pacific in 1906 at the age of 16 as a caller in the enginehouse at that point. He has been continuously in the service of the Union Pacific since that time, with the exception of three years during which he attended the University of Michigan. He is the designer of the Union Pacific's two latest streamliners, the "City of Denver," and is also one of the designers of the new trucks and a number of other mechanical innovations adopted on all Union Pacific streamliners.

Otto Jabelmann

THOMAS J. McDERMOTT, chief draftsman of the motive power department of the Delaware, Lackawanna & Western, has been appointed mechanical engineer, with headquarters at Scranton, Pa., to succeed the late Samuel S. Riegel. Mr. McDermott entered the service of the Lackawanna in 1903 as a machinist apprentice in the Scranton locomotive shops. He completed his apprenticeship in the drawing room in 1907, and in 1908 became assistant chief draftsman on locomotive work, power plant and shop layout. In 1910 he was appointed leading draftsman for shop and power plant work and in 1916 became leading draftsman with supervision over the drawing room under instruction from mechanical engineer. He was assigned to special work in 1919 and was in charge of mechanical branch inventory and for I.C.C. Order No. 8 covering equipment, machinery and power plant, reporting to the valuation engineer. Mr. McDermott has been chief draftsman of the motive power department since 1920.

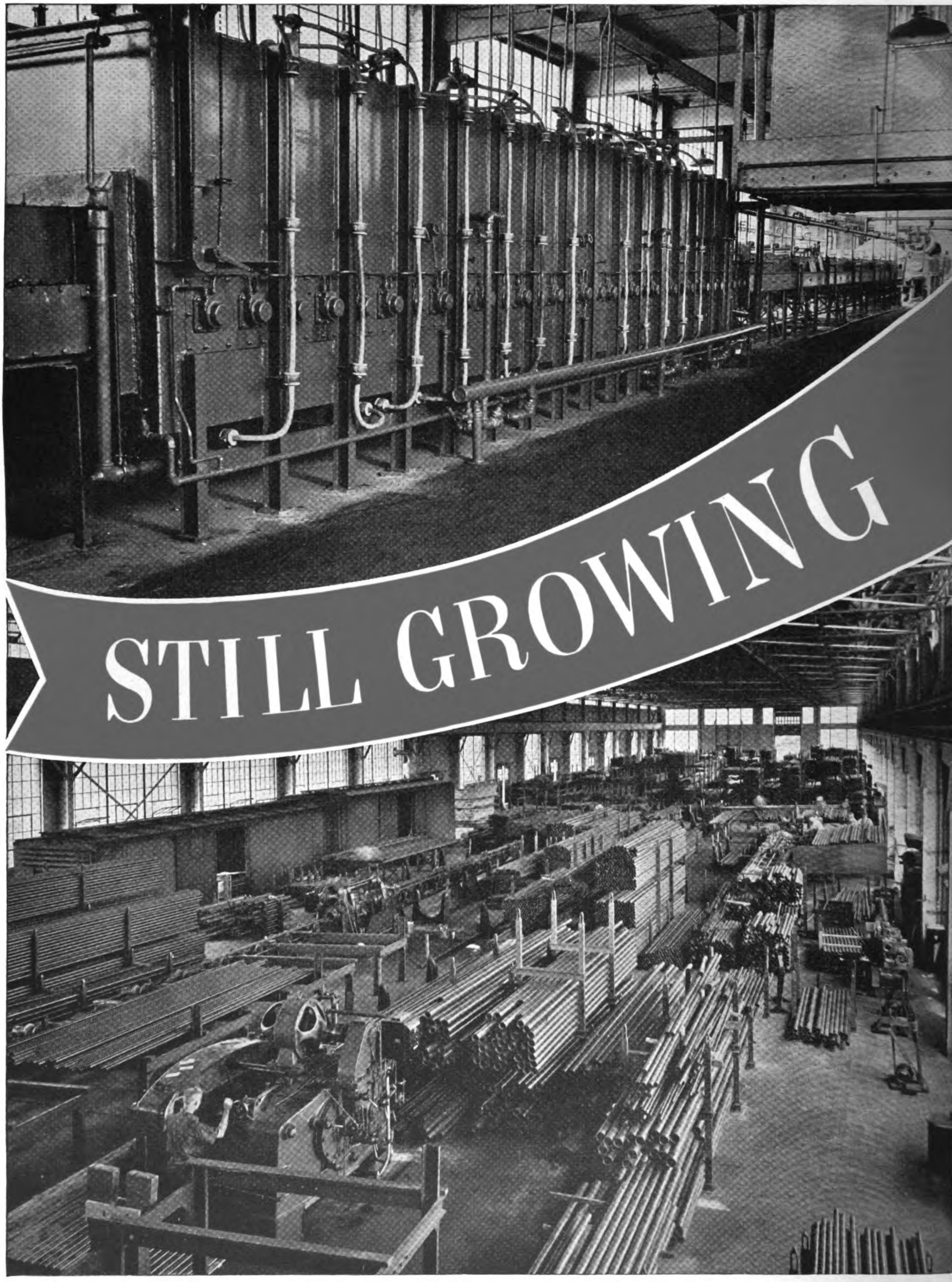
T. J. McDermott

J. M. KERWIN, master mechanic of the Illinois division of the Chicago, Rock Island & Pacific, with headquarters at Silvis, Ill., has been appointed district superintendent of motive power of the Chicago, Rock Island & Pacific, with jurisdiction in mechanical matters and with headquarters at Silvis, Ill. Mr. Kerwin was born on January 5, 1884, at Chicago, Ill., and was educated at Armour Institute of that city. He entered railway service on October 27, 1899, as a machinist apprentice on the Chicago, Rock Island & Pacific, and after serving as a machinist from October 28, 1903, to January 16, 1908, became assistant enginehouse foreman at Chicago. On May 1, 1911, he was promoted to enginehouse foreman at Silvis, Ill., which position he held until April 1, 1915, when he was appointed general foreman at Cedar Rapids, Iowa. Since April 10, 1916, he has been a master mechanic, being located at Estherville, Iowa, until January 31, 1918; at Silvis, Ill., from that date to April 15, 1919; at Goodland, Kan., from the latter date to May 16, 1923; at Trenton, Mo., from the latter date to October 15, 1926, and at Silvis, Ill., from the latter date to July 1, 1936, when he became superintendent of motive power of the First district.

J. M. Kerwin

D. S. ELLIS, mechanical assistant to the vice-president of the Chesapeake & Ohio, the New York, Chicago & St. Louis and the Pere Marquette, has been appointed chief mechanical officer of these roads and will report to the vice-presidents in charge of operation of the respective roads. In his new position Mr. Ellis takes over a portion of the duties of the late W. G.

(Continued on second left-hand page)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Black, vice-president in charge of purchasing, stores and mechanical matters. He will have his headquarters as before at Cleveland, Ohio. Mr. Ellis was born at Warwick, N. Y., on January 25, 1897, and attended the Warwick high school. In 1916 he became a clerk in the auditor's office of the Lehigh & Hudson River, and

D. S. Ellis

in the following year he was appointed a clerk in the office of the auditor of freight accounts of the New York Central. Later he served as a machinist and as acting enginehouse foreman. In 1918 Mr. Ellis became a draftsman, serving in this position and as a setter, calculator, designer and traveling engineer until 1924. In that year he was appointed assistant engineer and in 1925 became assistant engineer of motive power. On May 1, 1929, Mr. Ellis was appointed eastern district manager, and subsequently manager, of the railroad division of the Worthington Pump & Machinery Corporation. On October 1, 1932, he resigned from the latter position to become engineer of motive power on the advisory mechanical committee of the Chesapeake & Ohio, the Erie, the New York, Chicago & St. Louis, and the Pere Marquette, with headquarters at Cleveland. Early this year he was appointed mechanical assistant to the vice-president of the C. & O., the Nickel Plate and the Pere Marquette.

Master Mechanics and Road Foremen

W. H. Longwell, general foreman of the Baltimore & Ohio at Fairmont, W. Va., has been appointed acting master mechanic, with headquarters at Benwood, W. Va.

G. H. Nowell, division master mechanic of the Canadian Pacific at Moose Jaw, Sask., has been appointed master mechanic of the Saskatchewan district, succeeding Joseph P. Kelly.

Joseph P. Kelly, master mechanic of the Saskatchewan district of the Canadian Pacific, at Moose Jaw, Sas., succeeds E. G. Bowie as master mechanic of the British Columbia district, with headquarters at Vancouver, B. C.

A. Mays, general foreman of the Canadian National at Edmonton, Alta., has been appointed master mechanic of the Portage-Brandon Division, with headquarters at Winnipeg, Man., succeeding D. W. Campbell, retired.

F. D. Baldinger, master mechanic of the Baltimore & Ohio at Benwood, W. Va., has been appointed acting district master mechanic of the Maryland and West Virginia districts, succeeding A. E. McMillan, who has been granted a leave of absence because of illness.

Car Department

A. L. Looney, superintendent car department of the Union Pacific at Omaha, Neb., has been appointed general car inspector, with headquarters at Omaha.

Shop and Enginehouse

J. Thomson, assistant locomotive foreman of the Canadian National at Coalspur, Alta., has been transferred to Edson, Alta.

A. Clifton, locomotive foreman of the Canadian National at Drumheller, Alta., has been transferred to the position of locomotive foreman at Calgary, Alta.

M. A. Cardell, locomotive foreman of the Canadian National at Calgary, Alta., has been appointed general foreman, with headquarters at Edmonton, Alta.

C. F. McKinney, office engineer of the Erie, with headquarters at Cleveland, Ohio, has been promoted to supervisor of tools and machinery, with the same headquarters, to succeed N. B. Emley, deceased.

W. S. Spencer, a machinist of the Canadian National at Edson, Alta., has been promoted to the position of assistant locomotive foreman, with headquarters at Coalspur, Alta.

E. G. Bowie, master mechanic of the British Columbia district of the Canadian Pacific, with headquarters at Vancouver, B. C., has been appointed works manager of the Ogden shops.

A. D. MacMillan, assistant locomotive foreman of the Canadian National at Edson, Alta., has been appointed locomotive foreman, with headquarters at Rocky Mountain House, Alta.

H. Baylis, locomotive foreman of the Canadian National at Rocky Mountain House, Alta., has been transferred to the position of locomotive foreman at Drumheller, Alta.

Purchasing and Stores

C. E. Swanson, storekeeper on the Chicago, Burlington & Quincy at Galesburg, Ill., has been appointed traveling storekeeper, with headquarters at Chicago, to succeed Hal D. Foster.

G. O. Beale, assistant to the vice-president of the Chesapeake & Ohio, the New York, Chicago & St. Louis and the Pere Marquette, with headquarters at Cleveland, Ohio, has been appointed chief purchasing and stores officer of these roads, in which position he succeeds to a portion of the duties of W. G. Black, vice-president in charge of purchasing, stores and mechanical matters of these three lines, who died on June 20.

Obituary

John O. Looney, general air-brake inspector of the Norfolk & Western at Roanoke, Va., died on June 25. Mr. Looney had been in the service of the N. & W. for 37 years.

Edward J. Thill, engineering assistant to the assistant to the president of the New York Central, died on July 11 at his home in New York at the age of 54 years. Mr. Thill had been in the service of the New York Central for 37 years and at the time of his death was connected with the rolling stock division.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

Landis Thread Cutting Equipment.—Data concerning actual results obtained with Landis threading machines, die heads and collapsible taps are contained in the performance bulletin issued by the Landis Machine Company, Waynesboro, Pa.

Tool and Alloy Steels.—The shop data on tool and alloy steels presented by Joseph T. Ryerson & Son, Inc., Chicago, in its general data booklet of 192 pages, are non-technical and have been prepared to assist in securing and properly handling special steels.

Fabrication of 18-8 Chromium Steels.—An eight-page illustrated booklet issued by the Linde Air Products Company, 30 East Forty-second street, New York, discusses improvements in the technique of fabricating 18-8 chromium steels and the actual welding procedure.

Steam Drop Hammers.—The operation of the balanced slide valve on Chambersburg steam drop hammers is uniquely illustrated by moving a slide up and down on the colored diagram presented in the four-page folder issued by the Chambersburg Engineering Co., Chambersburg, Pa.

Diesel-Electric Locomotives.—An illustrated record of the 113 Ingersoll-Rand Diesel-electric locomotives now in operation has been issued by the Ingersoll-Rand Company, 11 Broadway, New York. Under each illustration is a brief record of the number, horsepower and tonnage rating of each locomotive, also the date placed in operation and the months of service to January, 1936.

Consolidated Catalog.—The American Brake Shoe & Foundry Company, New York, has issued Bulletin 36, of 32 pages, illustrating the products of its 13 subsidiary companies. Among products applicable to the railways are brake shoes, armored curbing, manhole covers, gratings grate bars, gears and other machinery parts, babbitt metal, journal bearings, trackwork and manganese steel castings, car wheels, welding rods and crossing signals.

Railway Mechanical Engineer

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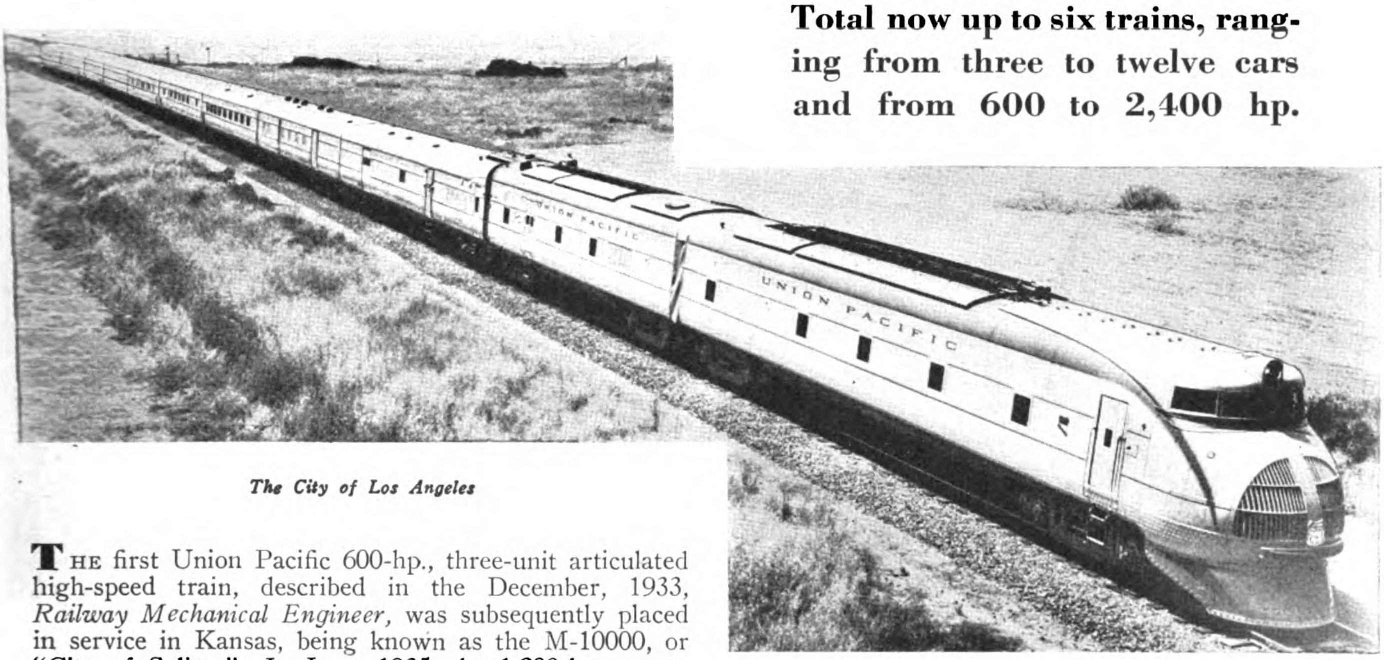
RAILWAY MECHANICAL ENGINEER

Union Pacific

Streamline Trains

Total now up to six trains, ranging from three to twelve cars and from 600 to 2,400 hp.



The City of Los Angeles

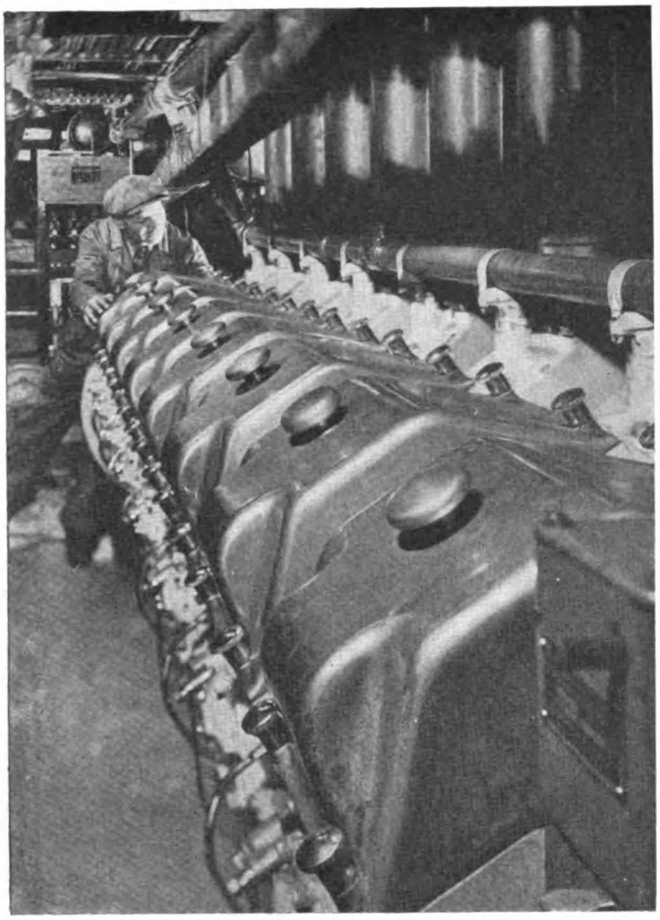
THE first Union Pacific 600-hp., three-unit articulated high-speed train, described in the December, 1933, *Railway Mechanical Engineer,* was subsequently placed in service in Kansas, being known as the M-10000, or "City of Salina." In June, 1935, the 1,200-hp. seven-unit train M-10001, or "City of Portland," was placed in service between Chicago and Portland, Ore.; and since May, 1936, four more trains have been placed in service between Chicago and individual western cities, as follows: M-10002, or "City of Los Angeles," consisting of nine body units and a two-unit 2,100-hp. locomotive; M-10004, or "City of San Francisco," similar to the M-10002, but having a 2,400-hp. locomotive; M-10005 and M-10006, the "City of Denver," each consisting of 10 body units and provided with a two-unit, 2,400-hp. locomotive.

All six of these trains, built by the Pullman-Standard Car Manufacturing Company and powered with internal-combustion-engine power plants having electric transmission, are constructed primarily of strong aluminum alloys, with the exception of the use of high-tensile alloy steel for certain castings and Cor-Ten steel for the locomotives on the last three trains. General information regarding the size, weight, seating capacity, power developed and types of cars used in each of these trains is shown in the large table, the scale truck weights on rail of four of the trains being given in a smaller table.

The original Union Pacific three-unit streamliner was conceived with the thought of providing high-speed passenger transportation at minimum cost, and with this objective in view the train width and height were decreased, the center of gravity lowered, the cars articulated and a streamline design selected having smooth, tapered sides which were intended to provide minimum air resistance. It soon developed, however, that, especially for long-distance transcontinental service, the traveling public is not disposed to sacrifice any of the spaciousness, comfort and conveniences to which it has become accustomed in conventional heavy steam trains, and consequently it was found necessary to restore some of the reductions in cross-section area, straighten up the car sides and insert additional cars in the trains providing diner, sleeper and lounge facilities. Referring to the comparative cross-section drawings, this change in trend of design is apparent, the three Pacific Coast trains being $4\frac{1}{2}$ in. higher and $7\frac{3}{8}$ in. wider than the original Union Pacific streamliner, and the twin Denver trains 2 ft. $5\frac{1}{2}$ in. higher and 1 ft. $\frac{5}{16}$ in. wider. The latter trains, which represent the last word in Union Pacific streamline train design, are, in fact, slightly wider, both inside and out, than conventional equipment, have equivalent head room inside and yet are 1 ft. 4 in. lower in roof height above rail.

All six of the Union Pacific streamliners are driven by power plants furnished by the Electro-Motive Corporation, with electric equipment supplied by the General Electric Company. Reference to the table will show that the power plant on the first train is distillate-electric, all others being Diesel-electric. All trains are equipped with roller bearings, either SKF or Timken, as shown in the table, and special electro-pneumatic, high-speed train brake equipment is of New York or Westinghouse make.

Referring again to the comparative table, differences



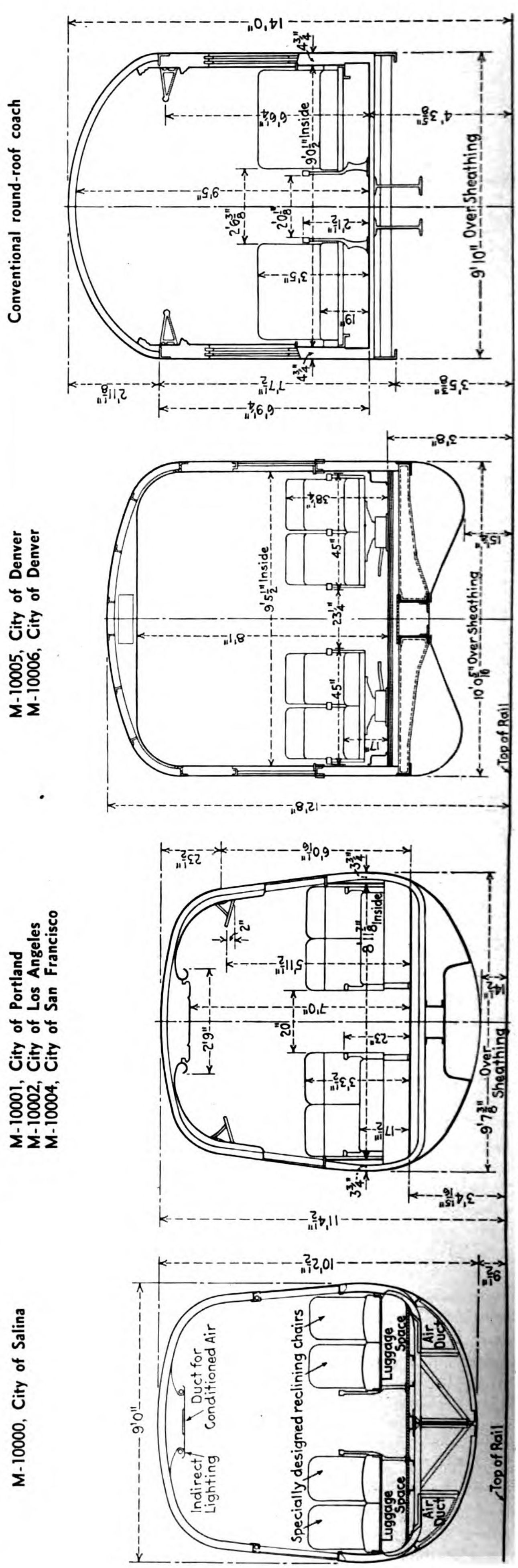
One of the 1,200-hp., 16-cylinder Diesel-engine power units

between the various trains will be apparent. The M-10000 consists simply of three articulated bodies with a single head-end power plant, provision to carry a limited amount of baggage, mail and passenger load and having a streamline metal end, housing a buffet. The M-10001 is somewhat larger in cross-section, has twice the power and includes four additional body units, three sleepers and a kitchen-diner-lounge. The M-10003 and M-10004 are further increased to 9 revenue body units to provide additional capacity in all services and a two-unit Diesel-electric locomotive. Each of these trains is fully articulated, with the exception of provision to uncouple the locomotive from the rest of the train. The M-10005 and M-10006 are increased to 10 revenue body units each, partially articulated in units of two, as shown, and have straight sides in conjunction with built-up underframes. In the locomotive of each of these trains, the cab is located about 10 ft. back from the nose of the leading unit, and, for the first time, the streamline buffet end is replaced by a more moderate streamline effect which permits providing a glass-enclosed observation end.

Body Design and Construction

The locomotive bodies of the M-10004, 5 and 6 are made of Cor-Ten steel with straight vertical sides and the cab set back. The circular engine-room sashes are set in chromium-plated frames. The front air intake grilles also are chromium plated. The thickness of Cor-Ten steel sheathing is as follows: 13 gage for the removable portion of the roof, for the sides, and for the curved bottom sheets adjacent to the sides of the car; 16 gage for the center bottom sheets below the power-plant well; and 11 gage for the curved sheets of the roof adjacent to the sides of the car.

The side posts are 3-in. Z-sections, weighing 5.1 lb.



Cross sections of Union Pacific streamline trains compared with that of a conventional round-roof coach

Union Pacific Diesel-Electric Streamline Trains Built by Pullman-Standard

Train number	M-10000	M-10001	M-10002*	M-10004	M-10005	M-10006
Train name	City of Salina	City of Portland	City of Los Angeles	City of San Francisco	City of Denver	City of Denver
Date placed in service	April 19, 1934	June 6, 1935	May 15, 1936	June 14, 1936	June 18, 1936	June 18, 1936
Structural material	Aluminum alloys	Aluminum alloys	Aluminum alloys	Aluminum alloys†	Aluminum alloys†	Aluminum alloys†
Type of construction	All-articulated	All-articulated	All-articulated‡	All-articulated‡	Partially articulated§	Partially articulated§
Number of cars (incl. power cars)	3	7	11	11	12	12
Total number of trucks	4	8	12	14	21	21
Normal seating capacity¶	116	118	170	170	182	182
Total number of individual seats	116	157	226	226	272	272
Overall train length	204 ft.	455 ft.	714 ft.	725 ft.	864 ft.	864 ft.
Total rated power	600 hp.	1200 hp.	2100 hp.	2400 hp.	2400 hp.	2400 hp.
Total light weight	190,070 lb.	568,880 lb.	950,318 lb.	1,005,600 lb.	1,250,450 lb.	1,250,450 lb.
Weight ready to run	200,140 lb.	597,280 lb.	1,005,588 lb.	1,064,300 lb.	1,333,900 lb.	1,333,900 lb.
E.-M., G. E. power plant	Distillate-electric	Diesel-electric	Diesel-electric	Diesel-electric	Diesel-electric	Diesel-electric
Type of roller bearings	S K F	S K F	S K F	Timken	S K F	Timken
Air brake equipment	New York	New York	New York	Westinghouse	New York	Westinghouse
Train consist:						
Unit 1	600-hp. power car‖	1200-hp. locomotive	1200-hp. loco. unit	1200-hp. loco. unit	{ 1200-hp. loco. unit	{ 1200-hp. loco. unit
Unit 2	Coach	Baggage-mail	900-hp. loco. unit	1200-hp. loco. unit	{ 1200-hp. loco. unit	{ 1200-hp. loco. unit
Unit 3	Coach-buffet	Diner-lounge	Baggage-mail	Baggage-mail	Mail car	Mail car
Unit 4	......	Sleeper	Kit.-bagg.-dorm.	Kit.-bagg.-dorm.	Baggage car	Baggage car
Unit 5	......	Sleeper	Diner-lounge	Diner-lounge	Bagg.-tap room	Bagg.-tap room
Unit 6	......	Sleeper	Sleeper	Sleeper	{ Coach	{ Coach
Unit 7	......	Coach-buffet	Sleeper	Sleeper	{ Coach	{ Coach
Unit 8	......	......	Sleeper	Sleeper	Diner	Diner
Unit 9	......	......	Sleeper	Sleeper	{ Sleeper	{ Sleeper
Unit 10	......	......	Coach	Coach	{ Sleeper	{ Sleeper
Unit 11	......	......	Coach-buffet	Coach-buffet	{ Sleeper	{ Sleeper
Unit 12	......	......	......	......	{ Pullman-observ.	{ Pullman-observation

* The number M-10003 is given to a reserve 2400-hp. articulated two-unit locomotive.
† Except for the 2400-hp. articulated two-unit locomotive made of Cor-Ten steel.
‡ Except for provision for separating the locomotive from the rest of the train.
§ Articulated in units of two, as shown by braces in lower part of the column.
¶ Exclusive of non-revenue seats in diner, lounge, cocktail room, observation end, etc.
‖ This car also includes space for baggage and mail.

per ft. The center sills at the power-plant well are Z-sections 26 in. deep, having 1/4-in. webs and 3/8-in. flanges 3 1/4 in. wide. They are formed of plates and angles electrically welded together. Side sills are provided in these structures by the use of 3 1/2-in. by 3 1/2-in. by 5/16-in. angles.

The trailing body units are built of strong aluminum-alloys throughout, with the exception of such parts as body bolsters and end sills, which are of high-tensile alloy steel. The structures are of tubular form with side and roof sheets .156 in. thick.

Each body has a box-type center sill comprising two 10-in., 8.84-lb. aluminum channels with 3/8-in. thick by 20-in. wide top and bottom cover plates, so designed as to resist a buffing load in excess of 400,000 lb. Center sills are connected to the side sills and sheets with 1/8-in. thick pressed-pan needle beams spaced approximately 6 ft. apart longitudinally of the car, with floor stringer supports spaced between the needle beams.

The side sill is a special extruded aluminum section, continuous in length throughout the car. The side posts are extruded flanged channel sections extending continuously from the lower edge of the needle beam to the top center of the roof, forming continuous side posts and roof carlines.

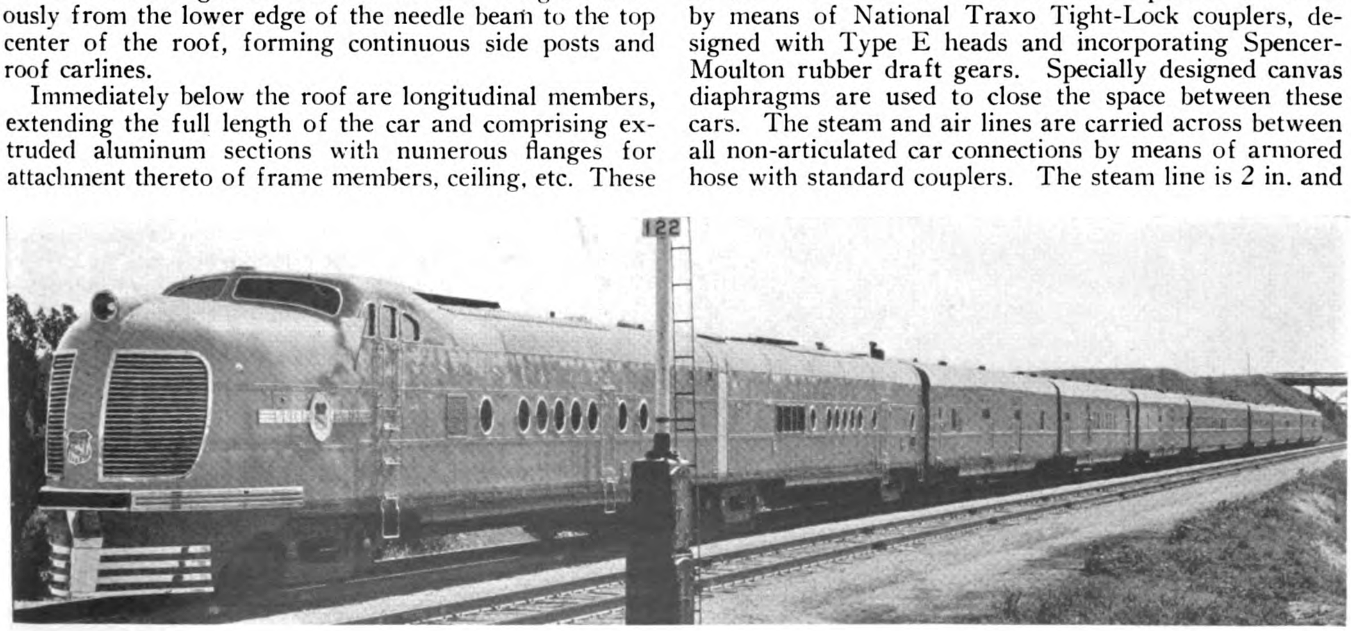
Immediately below the roof are longitudinal members, extending the full length of the car and comprising extruded aluminum sections with numerous flanges for attachment thereto of frame members, ceiling, etc. These channels, in combination with the roof and a bottom sheet, form the duct for air conditioning. The fastening of the side, bottom and roof sheets to the framing members is by 5/16-in. Huck rivets, except at points where rivets of a larger size are required.

Important cast-steel structural parts are of special heat-treated alloy cast steel. Conventional anti-telescoping features are built into the ends of the cars, consisting in this case of heavy aluminum plates extending across the car at the floor line back of the end sills and above the end doors of the cars.

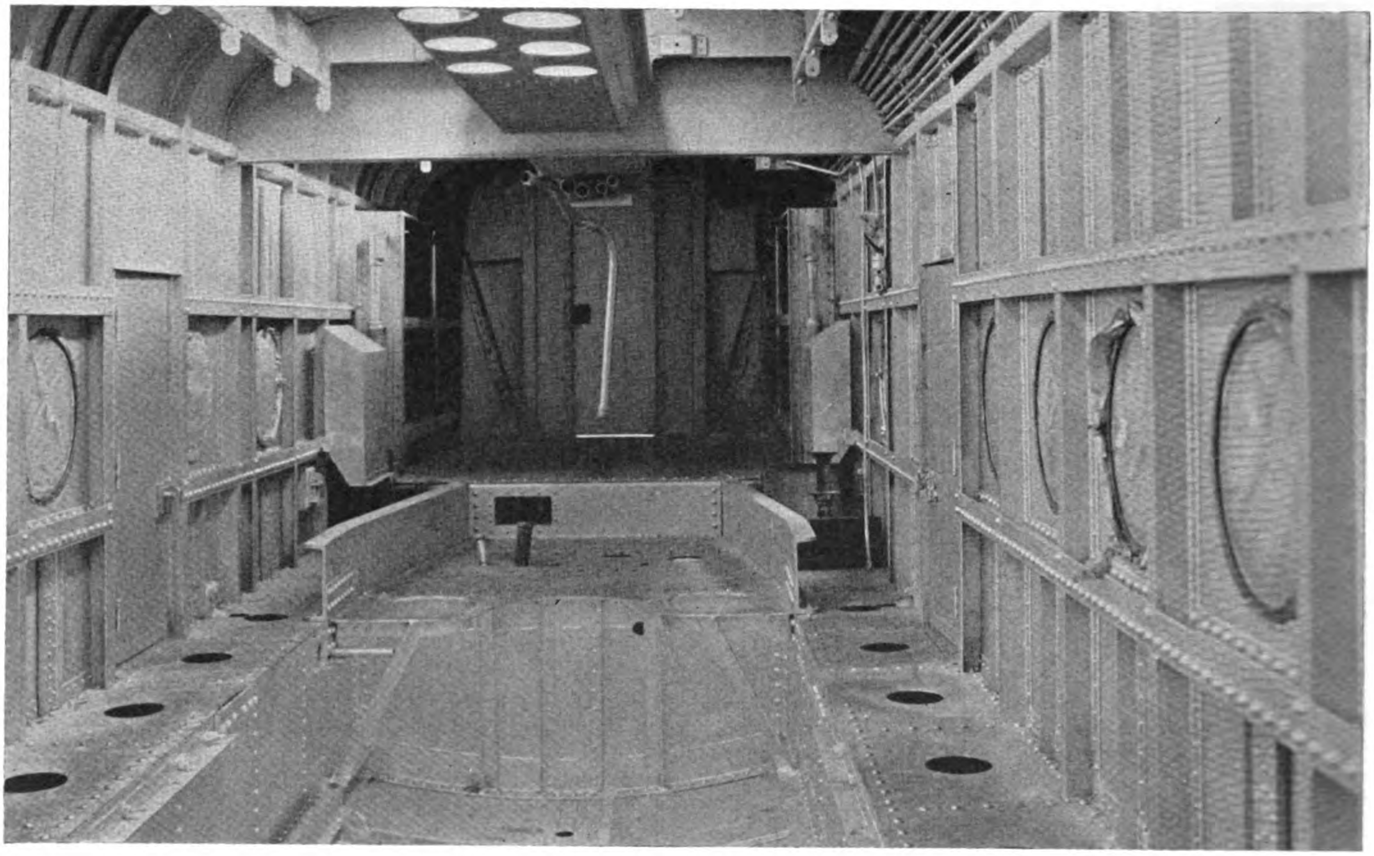
While both of the new trains embody primarily riveted construction, on the M-10004 train, for example, including the Cor-Ten steel locomotive bodies, there is a total of 7,690 lin. ft. of arc welding, 822 lb. of welding rod being used.

Articulated Connections between Body Units

The two locomotive body units of each train are articulated through a steel bridge casting which spans the rear truck of the front unit and the forward truck of the rear unit. The locomotive couples to the train by means of National Traxo Tight-Lock couplers, designed with Type E heads and incorporating Spencer-Moulton rubber draft gears. Specially designed canvas diaphragms are used to close the space between these cars. The steam and air lines are carried across between all non-articulated car connections by means of armored hose with standard couplers. The steam line is 2 in. and



The City of Denver



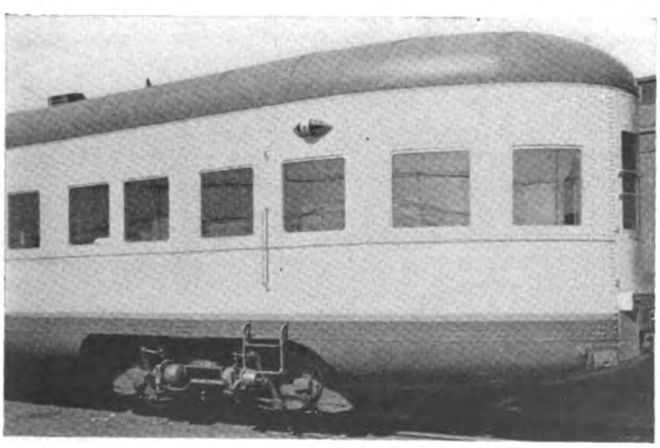
Interior of one of the Cor-Ten steel locomotive units in the course of construction

the air line 1⅛ in. Electric connections are made by means of Pyle National receptacles and ordinary jumpers.

The articulated trailing bodies have lubricated semi-spherical center plates extending from the end sills of adjoining cars and nesting in a common center plate cast integral on the truck bolster. A lock-type center pin is applied through each center plate nest as a safety measure. The gaps between the articulated bodies are entirely closed at the sides and roofs by means of diaphragms of extra-stretch pigmented rubber, spanning from one car to the next. The passageways between the cars are also enclosed, and dust-tight rubber inner diaphragms are used.

Drawbars are provided at both the front and rear ends of the train. The front drawbar is of the hinged type and the rear drawbar telescopes into the car; all openings both front and rear have flush cover plates.

In the locomotive, only the cab is insulated, the floor with 1-in. hair felt and the roof and sides with 2-in.



Rear-end construction of the City of Denver

light-weight Salamander. The trailing body units are insulated with 2-in. light-weight Salamander, covered with Sisalkraft paper on both sides. Insulation is supported from the back of the roof sheets and fastened to the inside of exterior side and end sheets with cement and metal bands. A further insulation is provided by heavy felt insulating paper, cemented to the back of all head-lining sheets and interior finish sheets in the passenger-carrying bodies.

The bottoms of bodies, which are completely closed, with removable doors giving access to equipment, are likewise insulated, the insulation, however, being entirely sealed with Sisalkraft paper to protect it against any condensation that may accumulate within the enclosed area. At the ends of the structures and over the truck pockets where the space is restricted, layers of cork insulation are used.

The main sash in the passenger and sleeping compartments of the M-10004 have Pittsburgh hermetically sealed dehydrated Unit-type glass in extruded aluminum frames. Each unit is made up of two lights of ¼-in. laminated glass. The toilet rooms and lavatories have similar dehydrated glass, the outer light being of Pressed Prism ¼-in. translucent design. The upper berths in the sleeping sections and in compartments in the bedroom car are fitted with dehydrated Unit-type sash, there being two sashes 12 in. wide in each berth fitted with Formica sliding panels to exclude outside light when not desired. The locomotive has single glazed ¼-in. safety glass in hinged aluminum sash frames.

All exterior side doors and end doors and interior doors are of aluminum construction. Passenger side entrance doors are of hinged type, swinging inward. Baggage- and mail-compartment side doors slide on curved upper guide and lower track designed to bring the doors flush with the sides of the train when closed. Main end doors and toilet-room doors in the passenger-carrying units are designed with an anti-pinch feature.

Forged steps, of designs to suit streamline train conditions, are provided for the cab and engine compartment, mail room and baggage compartment and loading side doors. Passenger entrance steps are of the pivoted type, operated with a sprocket and chain mechanism, so designed that the lower riser and tread form a part of the

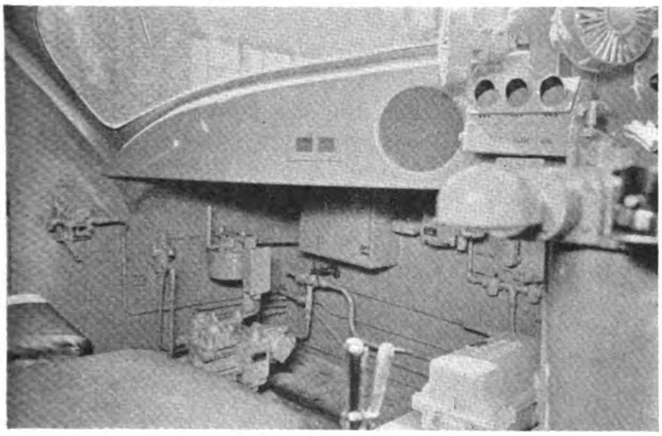
Union Pacific Train Scale Weights on Rail, Light, in Lb.

	M-10002	M-10004	M-10005, 6
Truck No. 1 (first locomotive unit)...	96,040	108,193	106,933
2 (first locomotive unit)...	75,415*	87,572*	87,442*
3 (second locomotive unit).	75,575*	87,572*	87,442*
4 (second locomotive unit).	87,410	108,053	108,173
5	54,918	55,410	63,170
6	53,740†	55,060†	41,665
7	63,840†	62,560†	42,410
8	63,580†	63,640†	44,040
9	69,720†	69,580†	44,855
10	66,440†	66,140†	50,440
11	70,680†	70,060†	46,970
12	66,680†	66,300†	46,820†
13	61,820†	61,380†	46,060
14	44,460	44,080	49,695
15	.....	.....	50,155
16	.....	.....	50,515
17	.....	.....	66,970†
18	.....	.....	50,875
19	.....	.....	51,475
20	.....	.....	68,650†
21	.....	.....	45,695
Total wt., car bodies only...........	617,572	679,370	819,480
Total wt., on rails, light............	950,318	1,005,600	1,250,450
Total wt., ready to run (with liquids).	1,005,588	1,064,300	1,333,905
Total wt., on rails, loaded...........	1,069,788	1,128,500	1,482,860

* Special bridge-connected trucks under articulated locomotive units.
† Trucks under ordinary articulated body connections.

platform and door threshold, and the back of the step lines up with the contour of the car shell and entirely closes the step opening when in raised position. No trap doors are used.

The exterior of the train is in two colors, leaf brown on the roofs down to the top of the letterboard and on the rounded bottom up to a line even with the bottom of the side door openings. A canary shade of yellow is

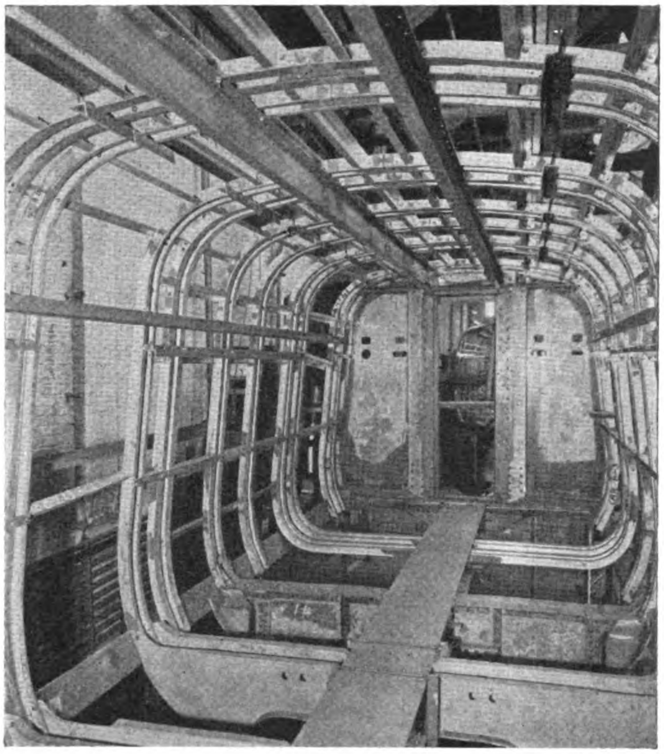


A.T.C. cab indicator and air brake equipment, including the Decelerometer, in the cab

used on the sides, separated from the brown with bands of scarlet, the top band being 1½ in. wide and the bottom band 2½ in. wide. The lettering is in gold leaf edged with black.

Heating and Air Conditioning

Each train is heated by dual Vapor high-pressure oil-fired boilers, burning the same fuel oil as that used in the main Diesel engines. Fin tubing and piping of copper is used in connection with a reduced steam pressure. The steam train line and other piping under live-steam pressure is of steel pipe. Flexible armored steam-line connections between the body units are looped upward so as to be self-draining. Standard Vapor metallic connectors carry the steam line across the space between the locomotive and the train. There are Pyle-National

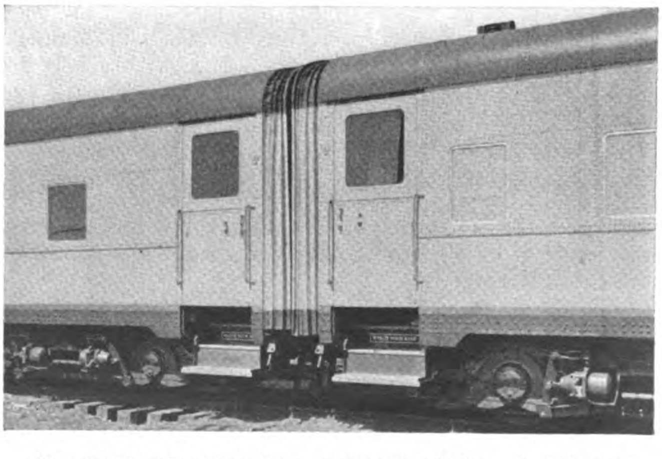


Construction of the aluminum-alloy underframe and tubular superstructure frame

receptacles and jumpers for the electric lines and standard air-brake couplings and hose for the air lines.

Each of the passenger-carrying units has air-conditioning equipment which comprises dual units for both (preheated air) heating and cooling, located in compartments, one on each side of one end of each unit. Each compartment contains in the lower section a complete condensing unit comprising a Frigidaire compressor and 220-volt, 3-phase, a. c. motor, driving the compressor, with a condenser fan mounted on the opposite end of the motor shaft and a condenser, a receiver tank and necessary piping. Air for condenser cooling is drawn in through the floor and blown out through the side of the car.

The upper section of the compartment comprises the cooling and heating equipment, including blower fans, filters, heating coil, cooling coil and the necessary piping, fittings, valves, etc. Air circulation is through a center overhead duct; in the sleeping cars there are branch ducts from the main duct to the berths. Fresh air in all cases is drawn in through the side of the car. The two units on each side of the car are connected in parallel.



Non-articulated connection between two of the passenger cars

Floor heat coils under thermostatic control are used as the balancing element in maintaining car temperatures. Thermostatic control is used for both cooling and heating. Essentially, this control is the same as used on standard air-conditioned cars. For ventilation purposes there are bottom rail sash ventilators in the dormitory car to supplement the roof exhaust fans. Exhaust fans are also provided in the dining and lounge sections, bedrooms, kitchen, buffet, mail room and crew's dormitory.

The brake equipment is of the Decelakron electro-pneumatic control, light-weight H S C type, with brake cylinders truck mounted. Aluminum tubing and flared fittings are used throughout except on the trucks and piping extending outside of the bottoms of cars, which is of heavy steel pipe. A lever-handle type of hand brake is provided in each of the locomotive units, at the forward end of the first trailing unit and in the rear unit.

Gravity tanks supply water for the toilet facilities in the second locomotive unit and in the mail compartment. For the balance of the train, a separate air-pressure water system is provided on each unit. Aluminum tubing and fittings for water supply are used throughout. The hot water supply is provided by means of jackets in the steam train line. The kitchen and buffet hot water is supplied through the ranges.

The interior finish and headlinings, throughout, are of aluminum-alloy sheet construction, with moldings and extruded sections also of aluminum alloy.

Power and Trailer Trucks

Each of the four four-wheel equalizer-type power trucks (per train) has an 8-ft. 4-in. wheelbase, 36-in. diameter rolled-steel wheels, and roller bearings mounted on special forging quality carbon-steel axles. Lebanon cast channel-shape side-frames are provided, with transom and end frames cast separately and bolted to the side-frames. All frame joints are machined; all holes are jig drilled and machine reamed to take 1-in. diameter turned bolts with Grip lock nuts. Hanger brackets for brake heads are cast as part of the transom and side frame.

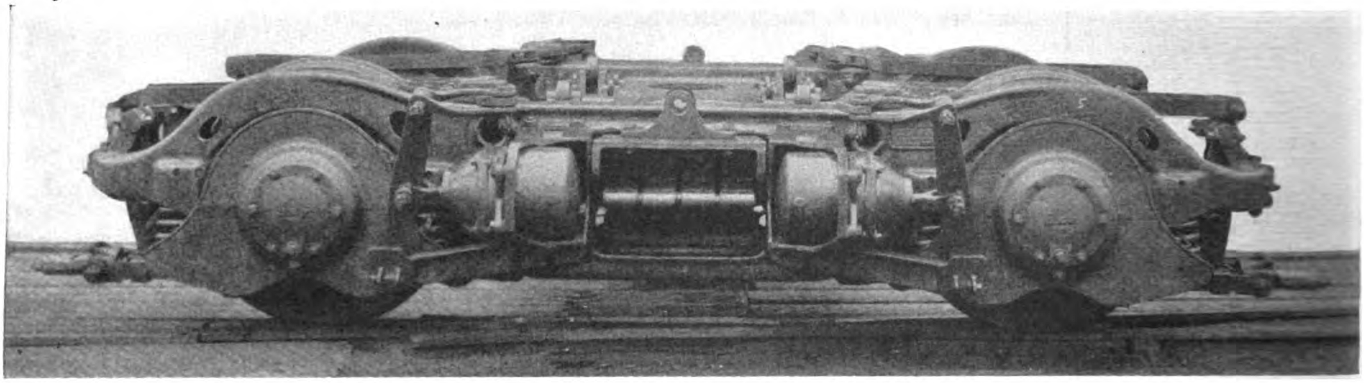
The spring suspension includes a double combination of long-travel coil equalizer springs and elliptic bolster springs. The truck frame is supported on equalizer springs seated on drop equalizer bars. All truck springs are made of either silico-manganese or chrome-vanadium steel, heat-treated.

Unit braking is used, with four cylinders per truck. The clasp brakes are designed for four 12½-in. shoes per wheel. The screw-type slack adjuster is manually operated. All brake members are spring joined to eliminate rattle. Brake heads are suspended with patented non-chattering balanced brake hangers, insuring even shoe wear and positive release. The entire brake rigging is designed to eliminate yield, making it very sensitive to application and release pressures.

Spherical-type truck center plates are cast as part of the truck bolster and sealed to form an oil reservoir for lubricating. All wear plates are of manganese steel with ground finish. Manganese-steel bearing surfaces are supported by rubber and wood blocks encased in the cast-steel side-bearing supports.

The trailer trucks are the new Union Pacific-Pullman Standard four-wheel type with 8-ft. wheel base and 34-in. diameter, cylindrical-tread rolled-steel wheels. The frames are heat-treated alloy-steel castings. The side frames are U-shape, box-cast trusses and the transoms cast box sections. The side frames and transoms are of the non-integral type, connected by bolting at the top and bottom. As in the case of the power trucks, all joints are machined and bolt holes jig drilled and machine-reamed for 1-in. diameter turned bolts with lock nuts. Hanger brackets for brake heads are cast integral as part of the transoms and side frames.

The spring system is a triple combination of long-travel, alloy-steel journal-box springs, short-travel intermediate bolster springs, and elliptical main bolster springs. The intermediate bolster springs are inserted between the transoms and the top spring-plank hanger fulcrums. The truck frame is mounted on helical springs, seated low at each side of the journal-box housing to provide long travel for these springs, and maintaining clearance for a low car floor. The ingenious combination of springs and suspension in this truck is designed to eliminate the harmonics and uncomfortable riding sometimes experienced in trucks of conventional design.



Union Pacific-Pullman-Standard trailer truck

The trailer trucks also have four brake cylinders per truck, truck mounted. Clasp brakes are used, with four 9-in. shoes per wheel. All brake members are designed to eliminate rattle and wear and brake heads are suspended by the friction-balanced brake-hanger arrangement mentioned to assure alignment and even shoe wear. No offset rods or levers are used, the entire brake rigging being specifically designed to deliver braking force directly to the brake shoes without yield or slippage, making the brake sensitive to application and release.

Side bearings at the articulated connections are manganese steel wear blocks, mounted on helical springs which are, in turn, supported by a differentially balanced rocker arm. Side bearings at non-articulating trucks are of the roller type.

Principal Features of the Power Plants

The power plants are of the Diesel-electric type, with a combined rating of 2,400 hp. Each main engine is a V-type 16-cylinder, high-compression, two-cycle oil engine of 8-in. bore and 10-in. stroke, developing a rated output of 1,200 hp. at 750 r.p.m. This is direct-connected

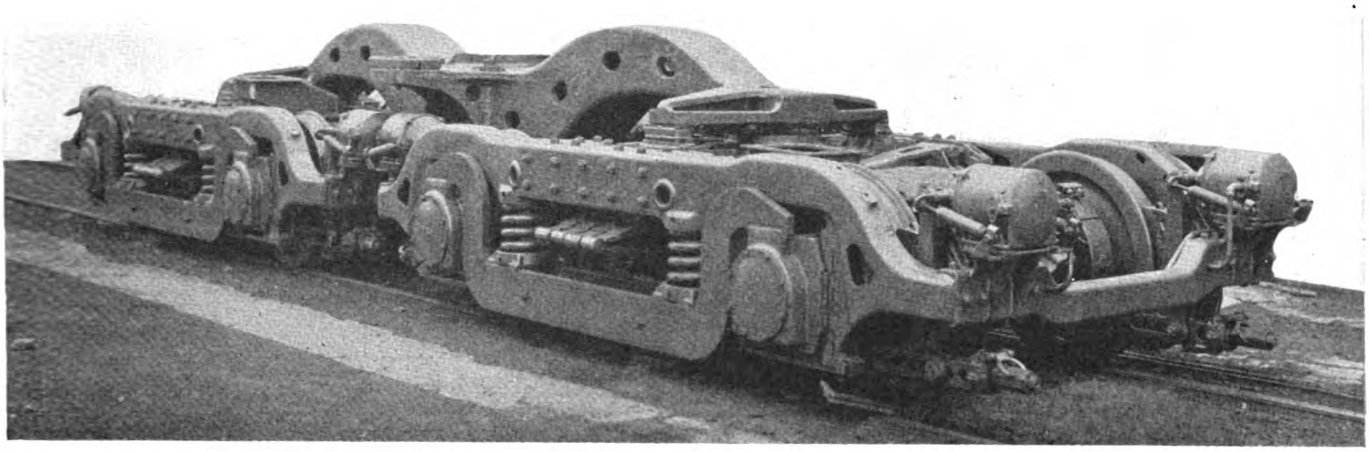
through a flexible coupling to a General Electric d.c. generator which furnishes electric power for the 300-hp. nose-suspended traction motors. Electric control equipment is of the P C L type. Each locomotive has a total of eight traction motors, two on each of the four motor trucks.

The main engines are cooled by means of radiators mounted in the roofs, the heat from the engines being dissipated to air which is taken in at the front end of each unit, passed through a partition forward of the engine in which are mounted four engine-driven fans, and discharged through the radiators to openings in the sides of the depressed trough in the roof. Cooling water for one of the auxiliary engines is piped into the main cooling system, and the other has its own cooling system of a character similar to that of the main engines.

A 32-cell MVAH 25-plate Exide Ironclad battery is furnished in each locomotive unit to supply power for engine starting, transmission control, cab and engine-room lights and emergency train lights. It has a capacity of 450 amp. hr. at the 10-hr. discharge rate.

All auxiliary electric power for the train is furnished the blower fans in each body unit for air conditioning, forced-air circulation, and in the case of the diner, to better proportion the electrical loading on the two plants. It also supplies power to the compressor motors at that point only. This second plant train line also supplies power to the kitchen refrigerators in the diner and in the buffet (rear), to the various appliances, such as drink mixers, toasters, etc., to exhaust fans, and to the radio receivers in the diner and buffet cars. Mail-car lighting is available on a.c. or d.c. through proper relay control, using the auxiliary plant battery as the emergency supply.

To prevent all compressor motors coming in at the same time on initiating service, a timing control line, fed from a master under-voltage relay in the baggage car, supplies a series of timing relays set at different time adjustments which permit the completion of control circuits between cooling thermostat relays and compressor motor starters only in the proper time sequence. Should an overload take place at any time, the under-voltage relay drops out for an instant, stopping all the motors, and then reconnects the timing circuit, which requires each motor to come in again at the proper time.



The intermediate power trucks are connected by a bridge casting which supports the locomotive articulated joint

by two 75-kv.a., 220-volt, 3-phase, 60-cycle Diesel-driven alternators with direct-driven 7.5 kw., 78-volt, d.c. exciters. The exciters are paralleled through proper reverse-current relay controls with MVAH-25 lead-type battery sets.

One auxiliary plant, located at the rear of the front locomotive unit, flanked by the battery compartments for this unit, supplies 220-volt, a.c., 3-phase current to all of the air-conditioning compressor motors which also drive the condenser fans. The exciter battery circuit furnishes d.c. for traction-motor controls, electro-pneumatic brake valves, sander valves and the train telephone system, with loud speaker and amplifier (220-volt, a.c. supply) in the cab. D.c. power is also used for the headlights, the marker lights, the engine-room lighting, windshield wipers, and anti-frost fans at the cab windows. This d.c. circuit is carried through the entire train, and also supplies operating current to all air-conditioning thermostat and valve controls.

The second auxiliary plant is located in a special compartment at the forward end of the mail and baggage unit and is flanked by a battery set at that point. This set, other than being used locally for starting up the Diesel engine and for local auxiliary room lighting, is kept in reserve but may be cut into the battery-circuit d.c. train line for the air-conditioning controls, etc., as required.

The 220-volt, a.c., 3-phase power is used primarily for lighting of the entire train, but is used also for operating

A cross-tie switch permits inter-connection of both electric train lines so they may be fed in common from either generating plant. For stand-by terminal service, 3-phase, 220-volt receptacles are provided at each car to allow using station power during layovers.

Train Control and Cab Signals

The locomotives of the City of Denver streamliners are equipped with a composite cab-signal and speed-control system. This equipment, furnished by the Union Switch and Signal Company, is designed for operation on the Chicago & North Western between Chicago and Omaha, Neb., as a two-indication cab-signal system with two-speed control. On the Union Pacific, between North Platte, Neb., and Julesburg, Colo., the equipment functions as a two-indication cab-signal system with a warning whistle and acknowledging feature. The cab-signal apparatus is similar to that in service on steam locomotives on the Union Pacific lines. However, as with the City of Portland, a new-type, compact, electric, speed governor is used in place of the older type governor used on steam locomotives.

The pneumatic equipment is of special design to provide the required train-control operating features in conjunction with the electro-pneumatic air-brake system designed for these high-speed trains. The air-brake equipment is so designed that the brakes can be operated either by straight air or by automatic air. Consequently,

the train-control apparatus is designed to function under both the straight-air and the automatic-air systems. The train will be operated normally on straight air, but if a train-control application should be initiated at such time when the straight-air lines are not intact, a full service automatic-air application will be obtained without any action on the part of the engineman.

The equipment is arranged so that the engineman may at all times retain control of the train braking, provided proper action is taken to observe the prescribed speed limits. If the engineman takes no action, the train-control brake application is initiated eight seconds after the speed limit is exceeded, or after the signal changes to the more restrictive indication if the speed is above the low speed limit. However, the engineman may suppress this brake application by initiating a manual brake application prior to the expiration of the delay time and maintaining it until the speed is reduced to the prescribed speed limit.

The train-control apparatus is cut out while the train is in operation over the Union Pacific cab-signal territory as well as in ordinary automatic block signal territory.

Headlights, Marker Lights, Signals, Etc.

The Pyle-National horizontal and vertical beam headlights are in a housing on the roof over the operator's cab. A General Electric electric speed indicator is driven from the end of one of the front power-truck axles, with a dial in the cab to show train speeds, which are governed by Union Switch & Signal automatic train-control equipment with cab signals. Marker lights on each side of the car close to the rear end of the train are practically flush with the contour of the exterior. These lights are wired to the battery circuit. Classification lights are provided at the front end of the operator's cab on each side of the locomotive, fitted with white and green lens.

An electro-pneumatic inter-train signal transmission system is employed, with pushbuttons conveniently located adjacent to each side door. In addition, an important innovation is the Automatic Electric intercommunicating telephone system installed for the exclusive use of the train crew. The Magnetic Monophone principle is employed. There are four telephone stations, including one in the locomotive cab, one in the second locomotive unit, one in the front baggage section, and one in the buffet-coach.

Warning devices consist of a dual pneuphonic horn and a 50-lb. Hammett bell with bell ringer. A pneuphonic warning horn is also located at the rear end of the train for use during back-up operations. A specially designed rubber bumper is applied at the front end of the locomotive.

City of Denver Trains Best Equipped and Fastest

The Union Pacific twin streamlined City of Denver trains are not only the longest and largest but best equipped trains yet placed in long distance service. These trains also operate on the fastest long-distance schedule in regular service in this country, making the 1,048 miles between Chicago and Denver, Colo., in a total elapsed time of 16 hours, including eight station stops, or at an average speed of 65.5 m.p.h.

In addition to three Pullman sleeper units, a Pullman bedroom-observation unit and a diner, this train also carries two coaches. Complete air-cooling and conditioning equipment is installed to furnish an adequate supply of clean, tempered air in all passenger compartments. The train is provided throughout with special lighting fixtures which produce pleasing effects and furnish adequate light for general illumination, reading, night lights, etc., dependent upon the requirements.

Still another unique feature is the equipment of one of the baggage cars just ahead of the coaches with a replica of a frontier tavern, called the "Frontier Shack," which is authentic in every detail. In it is installed a radio. A second radio has a loud speaker in each coach and there is a third radio in the observation room. Radio reception is also available in the dining car.

The dining car is not only fully equipped with a modern kitchen, dining section and cocktail room, but, like other passenger cars in the train, employs a generous use of Flexwood natural wood veneer and treated aluminum trim to secure beautiful and artistic interior effects.

The cocktail-lounge section is separated from the dining room by a low partition, topped with an etched edge-lighted thick plate glass. The partitions between the cocktail-lounge section and the lobby have ornamental welded design aluminum grilles.

Special Features of the Pullman Cars

The two bedrooms in the second sleeper unit and four of the five bedrooms in the rear body unit are built en-suite; that is, arranged with sliding partitions between each pair of rooms which can be thrown back to form a large room. Each bedroom has a sofa with folding armrest, the sofa back being specially designed so that, when raised, it serves as an upper berth. All cushions and mattresses are of rubber construction.

The first and third sleeper units have open sections and the second has sections enclosed with louvered panels. Both open and enclosed-section units are decorated in three shades of tan enamel. The compartment walls in the enclosed-section sleeper unit are decorated in three shades of blue, with a tan twist-weave carpet. The seat covering is in henna and the window shades are of rose color. The bedrooms are finished in three shades of tan, with tan twist-weave carpet, sea green mohair seat covering and ecru window shades with a tan horizontal stripe design. The general color scheme in the washrooms is three shades of blue. The window-shade material is of the rose color used in the main room.

The bedrooms and compartments in the rear unit have the same color schemes as given above and the observation room is finished in two shades of tan with an ivory ceiling.

Novel Lighting Fixtures

The lighting fixtures, throughout the train provide artistic lighting effects. General illumination is given by both direct and indirect light. A distributed light intensity of 10 foot-candles is available, without glare, at the reading plane. Subdued blue light is provided for night use.

In the Pullman units, an adjustable lower-berth reading light is used for the first time, which permits the occupant to direct the light where it is most needed to meet the requirements of his particular position. A blue night light, within the fixture, is controlled by a double-throw toggle switch with a luminous tip. On the ceiling, a continuous combination direct-lighting fixture and air-conditioning distribution duct is used, running from one end of the car to the other. This also has blue night lights within it which are controlled by separate switches.

In the Pullman bedroom-observation unit, a semi-indirect louvered trough light is used, which is applied above the windows and continues completely around the interior. It is constructed so that 70 per cent of the illumination is thrown onto the reading plane, 20 per cent is reflected to the ceiling, and, for decoration, 10 per cent is directed through a blue-colored screen and reflected onto the face of the trough. This trough is curved around the end of the car.

Busch-Sulzer

2,000-Hp. Switcher

Illinois Central Diesel-electric locomotive weighs 173 tons and is powered by a single Diesel-engine-generator set

THE Illinois Central has recently placed in heavy freight transfer switching service at Chicago the most powerful, single-unit, Diesel-electric locomotive so far constructed in this country. This locomotive, built for the Busch-Sulzer Bros. Diesel Engine Company, St. Louis, Mo., by the General Electric Company at Erie, Pa., is designed to combine a high degree of simplicity, rugged construction and ease of maintenance, with ample capacity, both mechanical and electrical, to assure reliable performance in the service assigned. It develops 2,000 hp. and weighs 173 tons.

Principal Features of the Diesel Driving Engine

The heart of the locomotive is the new Busch-Sulzer, 2-cycle, 10-cylinder, V-type Diesel engine which is conservatively rated at 2,000 brake horsepower at 550 r.p.m. in continuous service. The principal dimensions of the engine are shown in the table.

As the service for which the locomotive is intended demands a high starting tractive effort, it was found that an engine weight of 36 lb. per brake hp. could be employed to advantage. The same engine can be built with a weight of 23 lb. per hp. where service conditions necessitate lower weight.

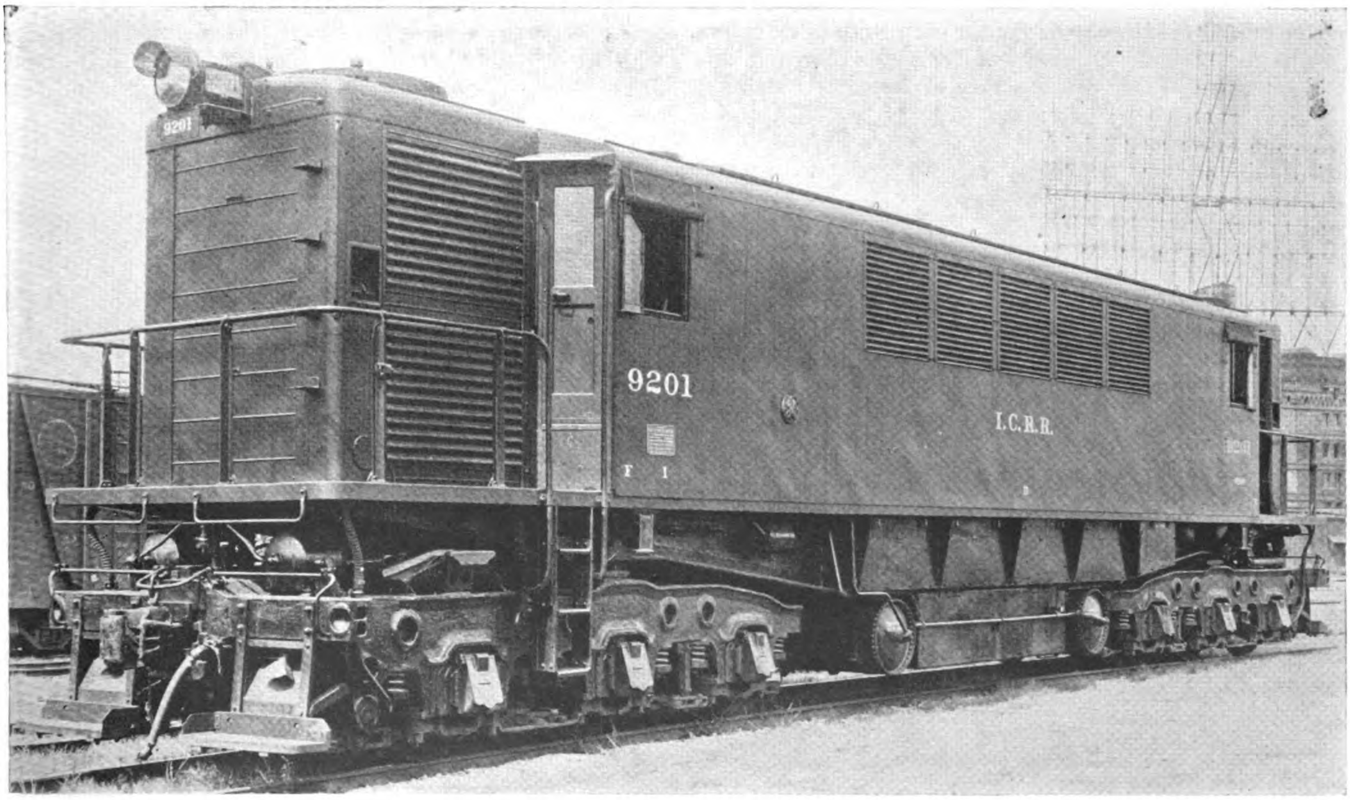
The engine is of the single-acting, mechanical injection, trunk-piston type, having 10 working cylinders arranged in two banks of 5 cylinders each, operating on the Diesel cycle. The angle of the vee between the cylinder banks is 45 deg.

Scavenging air is supplied by gear-driven, Roots-type, rotary, positive-displacement blowers which are mounted across the top of the vee between the two banks of cylinders. The blower housings act as covers and the vee is thus utilized as the receiver for the scavenging air.

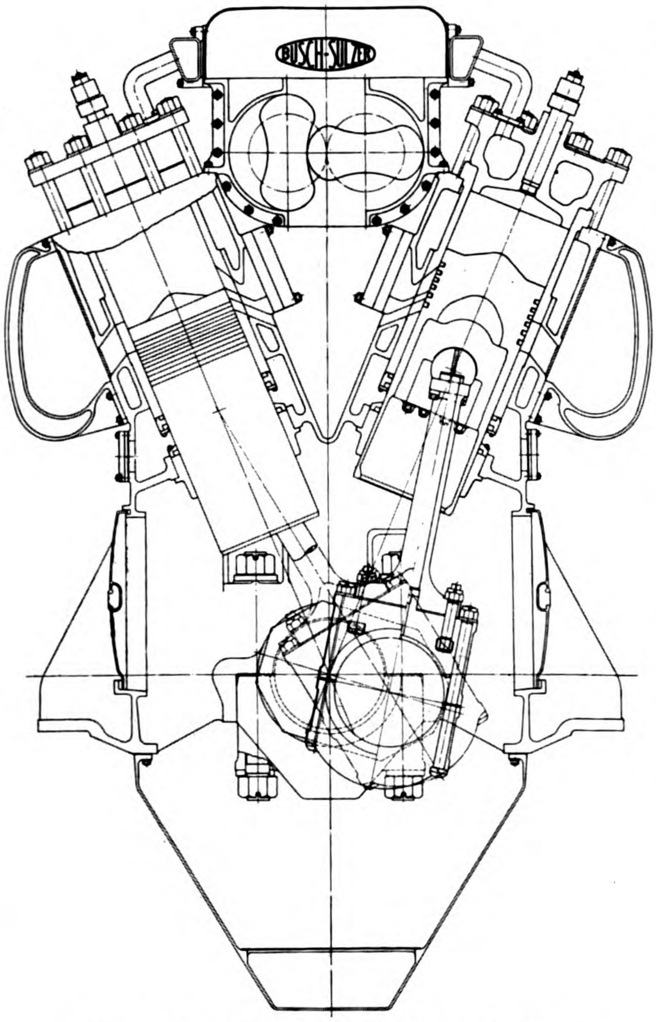
The engine is started by applying power from the locomotive storage batteries to the generator attached to the engine crankshaft. During the starting period, the generator, therefore, acts as a starting motor.

The pumps for circulation of lubricating oil are integral with, and directly driven by, the engine. The lower pump, referred to as the scavenging oil pump, draws the oil from the sump in the engine crankcase and forces it through a filter and the cooling radiators into surge tanks. The upper pump draws the oil from the surge tanks and forces it into the main lubricating supply header which distributes it to all points of the pressure lubricating system.

The fuel oil booster pump is mounted on a bracket integral with the lubricating oil pump housing, and is driven by an extension of the lubricating oil pump shaft. The centrifugal pumps for circulation of jacket cooling water are mounted on the engine, and are driven by



Ilinois Central Diesel-electric locomotive powered with 2,000-hp. Busch-Sulzer engine and General Electric electrical equipment



Cross-section of the 2-cycle, V-type Diesel engine

extensions of the fuel measuring pump camshaft. Two water pumps are provided, one for each bank of cylinders.

The fuel measuring pumps and the governor and control mechanism are mounted in a housing extending across the end of the engine farthest from the generator. The pumps are driven by gears and a vertical shaft from the end of the engine crankshaft.

Pistons are made of cast aluminum. The wrist-pin bearing is provided in a separate housing which is inserted into the piston from below. The piston skirt is, therefore, not pierced by the wrist-pin, resulting in a construction that permits full freedom for expansion.

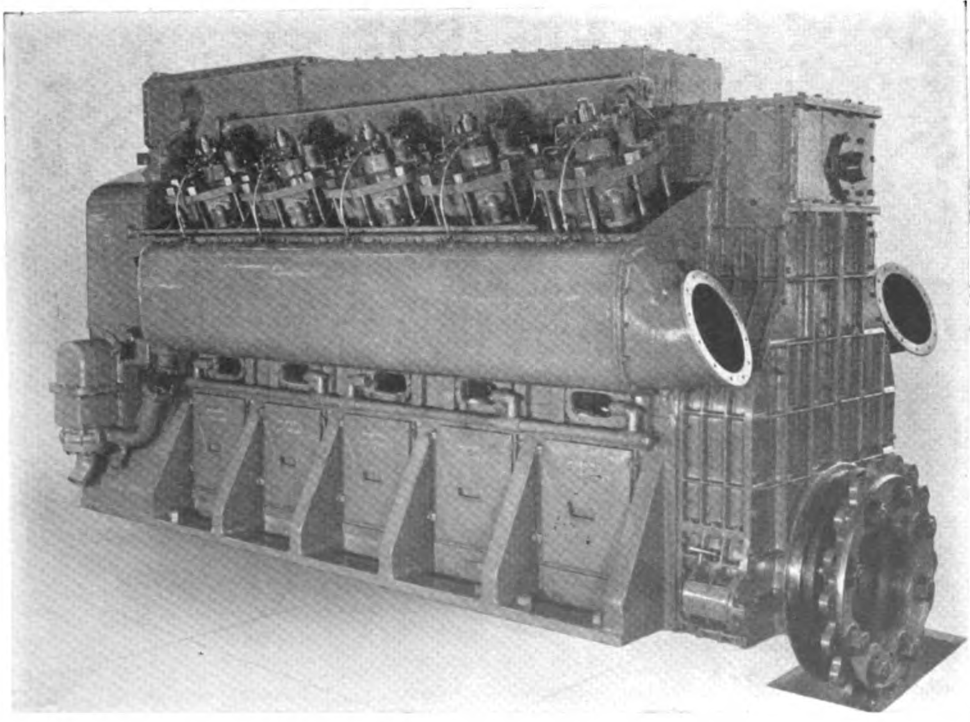
The design of the working cylinders incorporates the use of an upper and a lower cylinder liner, the upper liner containing the scavenging and exhaust ports. The lower cylinder liner is inserted into the engine frame from the inside the crankcase. Both of these liners extend into a so-called "sludge chamber," there being a gap between the ends of the liners which permits unobstructed inspection of the piston while the engine is running. The sludge chambers are equipped with glass inspection covers for this purpose and electric lights are provided to illuminate the sludge chambers.

The lower end of the upper cylinder liner is provided with a segmental type sealing ring and an oil wiper ring. The lower cylinder liner carries an oil wiper ring. All oil scraped from the piston skirt by the wiper rings is returned to the engine sump. That scraped off by the upper rings collects in the sludge chamber, from where it drains off continuously. That scraped off by the ring in the lower liner is piped back to the engine sump. All of this oil is recirculated through the main lubricating oil system.

The sludge chambers are continuously ventilated through ducts which connect to the scavenging blower suction. The ventilating ducts are provided with centrifugal oil separators which catch all lubricating oil that is held in suspension and return this oil to the crankcase sump.

The above described sludge chamber design provides the following features and advantages over the conventional engine construction. No hot combustion gases, or sparks, can enter or heat up the crankcase; lower crankcase and lubricating oil temperatures tend to lower the consumption of lubricating oil.

The action of the two sets of wiper rings, which are located above and below the sludge chamber effectively prevents excessive quantities of lubricating oil from being



The Busch-Sulzer 2,000 brake-hp. Diesel engine

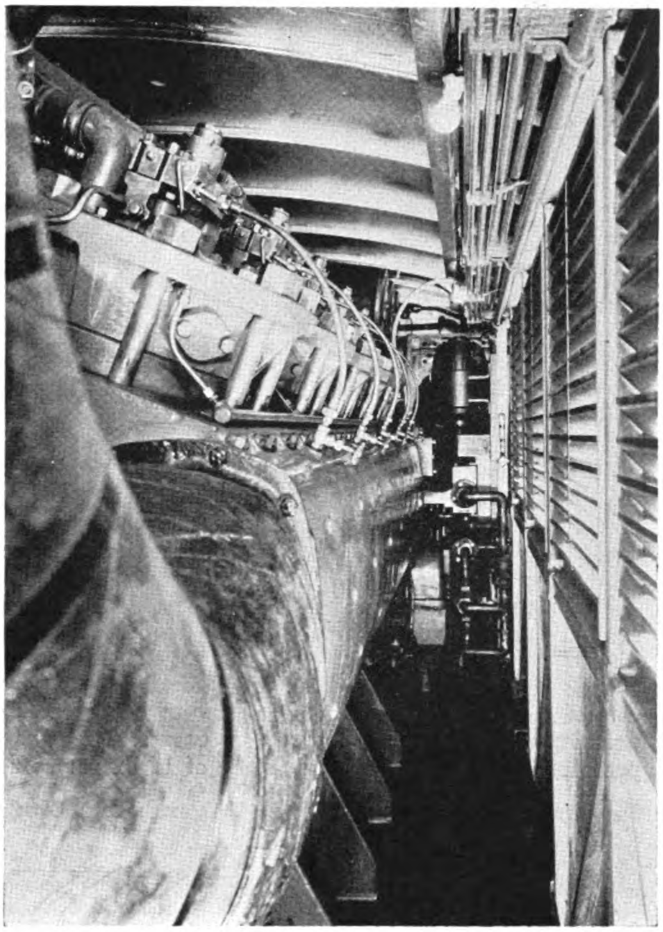
carried from the crankcase into the cylinder by the piston skirt. This, of course, results in a large saving of lubricating oil which would otherwise be wiped into the cylinder ports and eventually lost when carried out into the exhaust headers. It is also possible to adjust the feed of the cylinder lubricators so that just the proper amount of lubricating oil is supplied to the pistons and rings, since the condition of the pistons can be determined by inspection through the sludge chamber inspection covers.

Cylinder liners are made of a special alloy cast iron. The upper liners are fastened only at their upper flanges, thus providing full freedom for expansion. The lower liners are fastened only at their lower flanges, thus providing also full freedom for expansion.

The engine frame is made of cast iron and includes the crankcase with cross girders and bearing saddles, as well as the cylinder jackets for both banks of cylinders. Special alloy-steel bolts and studs are used where required by stress conditions. The materials used in the construction of fuel pump parts, fuel valves, etc., are especially selected to minimize wear and breakage. The well-known "Hesselman" system of fuel injection is incorporated.

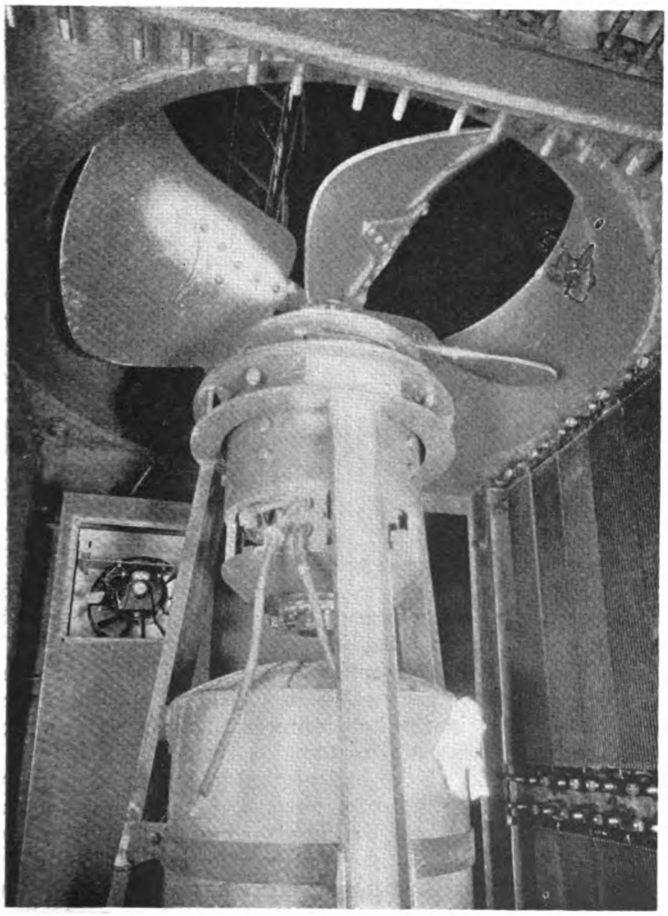
The design of the engine incorporates a so-called "underslung" crankshaft which is supported in bearing caps which register in, and are bolted directly to, the cross girders in the crankcase.

An oil pan, or trough, which is bolted under the engine frame, acts as a collector for all lubricating oil that drains from the various engine bearings. Since the scavenging oil pump continuously pumps out all oil that collects in the trough, the engine operates with what is commonly referred to as a dry sump. No large quantities of oil collect in the crankcase where it would be broken up into spray or vapor by the fanning action of the cranks.

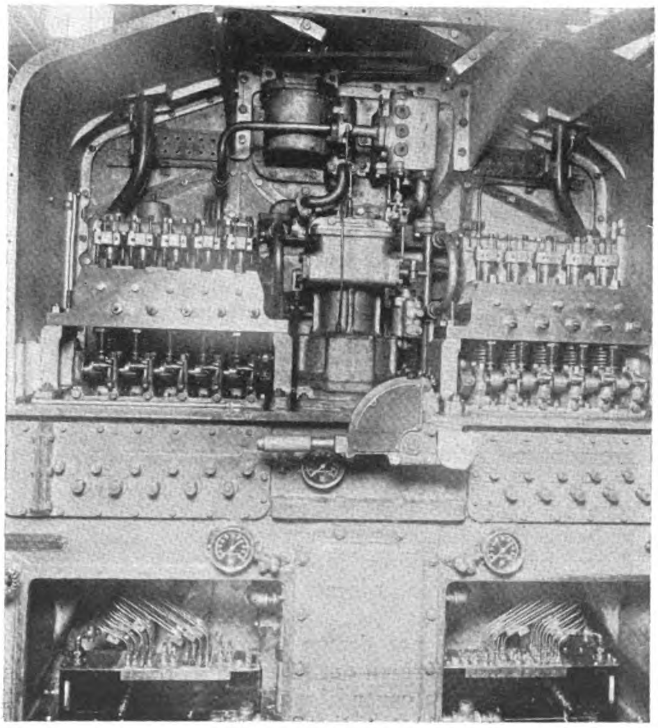


Engine room view, showing one bank of cylinders

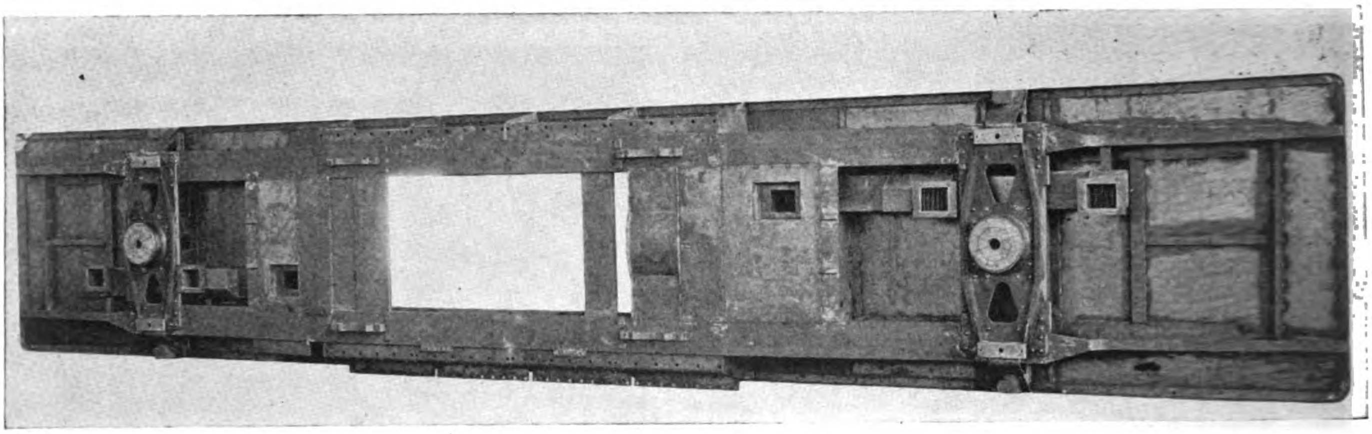
All engine bearings, gears and control mechanism are pressure-lubricated. The engine control servomotor and the governor relay are also operated by pressure oil



Radiator compartment showing the arrangement of the vertical fan



Free end of the Diesel engine, installed in the locomotive, with the covers removed



Welded fabricated steel underframe for 2,000-hp. locomotive

from the main lubricating oil header. The engine controls are, therefore, arranged so that the engine cannot be started, or operated, on fuel unless a minimum pressure of 12 lb. per sq. in. is registered in the pressure lubricating system.

If the pressure in the system drops below 12 lb. per sq. in., due to a break in a main feed line, loss of oil in the system, or sticking open of a relief valve, the engine will immediately be shut down. The engine cannot be re-started on fuel unless the cause for the pressure drop is determined and corrected and the pressure brought up to the minimum of 12 lb. per sq. in.

Engine Speed Control — Starting and Shut-Down Devices

The speed of the engine is regulated by a variable-speed governor which is adjusted to control the operation of the engine within the range from 275 r.p.m., idling speed, to 550 r.p.m., maximum speed. The engine may be operated at any desired speed within these limits.

An overspeed safety governor is also provided. This unit functions entirely independent of the main variable-speed governor and is set to prevent the engine speed from increasing more than 10 per cent above its maximum speed of 550 r.p.m. If the engine speeds up to a point higher than approximately 605 r.p.m., it will, therefore, automatically be shut down and re-starting will not be possible until the overspeed cut-out mechanism has been re-set. This re-setting can only be done at the engine.

The control lever, located at the fuel pump end of the engine, is used when starting the engine and can also be used for stopping it. A pneumatically operated shut-down device is also provided which is operated from the control station in the operating compartment of the locomotive. The engine cannot be started from the engineer's cab; this can only be done by operating the main hand-control lever located at the forward end of the engine.

The crankcase and the sludge chambers of the engine are ventilated through ducts which are connected to the suction side of the scavenging blower air intake. Two separate ducts are provided, one for crankcase ventilation and one for sludge chamber ventilation. Each of these ducts, or suction lines, is provided with a centrifugal oil separator, which is located near the suction intake of the blower.

As the vapors are drawn through the separator, all suspended oil is thrown out, due to the increased velocity and rotary motion caused by the vanes in the separator. After passing through the separator, this mixture of vapors and air must also pass through a filter unit before entering the blower suction. This filter unit effectively removes all trace of oil vapors that may still be suspended in the air after it passed through the centrifugal separator.

Working Principle — Method of Operation

During the first few revolutions of the engine in starting, the compression in the cylinders is relieved, but as soon as the engine picks up sufficient speed, the compression-relief gear is cut out and fuel is supplied to the engine. When the cylinders commence firing, the power from the storage battery is shut off. The engine controls are designed so that it is impossible to start the engine on fuel unless the pressure in the pressure lubricating oil system is at least 12 lb. per sq. in. It is, therefore, necessary to operate the motor-driven lubricating oil priming pump before attempting to start the engine.

In a Diesel engine, air is compressed in the working cylinder on the up stroke or compression stroke of the piston to about 500 lb. per sq. in. pressure. The temperature of the air, after compression to this pressure, is high enough to ignite the finely atomized fuel which is injected into the combustion space shortly before the piston reaches upper dead-center. The fuel is injected into the cylinder by a timed fuel-measuring pump which forces the fuel oil through an atomizing nozzle.

Scavenging, i.e., the purging of the working cylinder after combustion of the fuel, is effected through two rows of ports in the cylinder walls which are located on the opposite side from the exhaust ports. The ports in the upper row are controlled by automatic valves which do not open until the pressure within the cylinder has dropped close to atmospheric pressure after the piston has uncovered the exhaust ports. The scavenging air expels the burnt gases and fills the cylinder with fresh air at a pressure slightly higher than atmospheric, so that, at the beginning of the compression stroke, the cylinder contains a greater weight of air than it would contain at atmospheric pressure.

The cycle of operation in the cylinder is completed in two strokes of the piston or one revolution of the crankshaft. Fuel is injected into the cylinder by the fuel-measuring pump, beginning about 36 deg. before the piston reaches upper dead-center. The finely atomized fuel is ignited in the hot compressed air and the gases thus formed drive the piston downward.

Near the end of the end of the down stroke (expansion stroke), the exhaust ports are uncovered by the piston, the burnt gases escape through these ports and the pressure drops to about atmospheric. At this point, the upper row of scavenging ports has already been uncovered by the piston, the automatic valves controlling

the ports are opened and scavenging begins. When the lower scavenging ports are uncovered, additional scavenging is obtained and the cylinder is completely scavenged.

During the following up stroke of the piston, scavenging and the charging continue until the piston covers the exhaust ports. From this point, until the piston covers the upper scavenging ports, the cylinder is being supercharged, so that, when the piston does cover the upper scavenging ports, the pressure of the charge within the cylinder is about equal to that of the scavenging air supply. Compression begins as soon as the piston covers the upper scavenging ports. Fuel injection begins slightly before the upper dead-center, as stated, and the cycle is repeated.

Mechanical and Electrical Features of the Locomotive

The cab, running gear and electrical equipment of the Illinois Central Busch-Sulzer locomotive were designed and manufactured for Busch-Sulzer by the General Electric Company. Referring to one of the tables, overall dimensions and detailed weights are shown. The locomotive develops 36,500 lb. continuous tractive force at 16.5 m.p.h. and 86,500 lb. tractive force, assuming a maximum ratio of adhesion of 25 per cent.

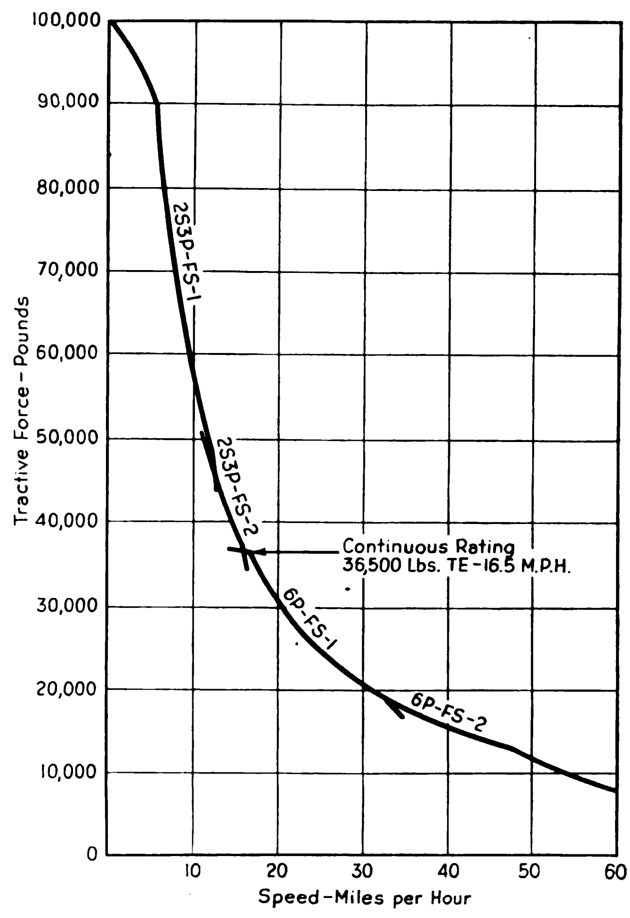
By taking advantage of the maximum bridge loading permitted by the railroad, it was possible to limit the number of axles to six and thereby design a simple running gear consisting of two three-axle, non-articulated swivel trucks upon which the cab is mounted.

The problem of holding the total weight within limits, permitting the use of six axles, was a serious one, without resorting to extensive use of special material in the cab. However, by putting the draft gear on the trucks, no part of the platform carries more than one-half of the drawbar pull; and by using a heavy centerplate, a suitable design was obtained. The trucks, centerplate and cab underframe are designed to withstand a buffing load of 710,000 lb.

The frame of each truck is an integral casting, of substantial construction throughout. A bridge structure is used between the front end frame and the two middle transoms for carrying buffing stresses direct to the center bearing. In the box sections of the side frames, the equalization and semi-elliptic spring systems are carried. Coil springs are interposed between the truck frame and the ends of the semi-elliptic springs to absorb high frequency vibrations. Standard boxes carry 7½-in. by 14-in. journals. Wheels are 39-in. rolled steel with floating babbitt-faced hub liners. The friction draft gear is carried in a pocket cast into the frame. Two 14-in. by 10-in. brake cylinders operate the extremely heavy brake work which is completely equalized. A single flanged shoe is used on each wheel, brake adjustment being made by a turnbuckle at the front end of the truck where it is accessible. Braced and illuminated end steps with splash guards are a feature. The truck design throughout is gaged to stand the punishment of heavy freight work, and the riding qualities are exceptionally good.

Each axle carries a General Electric 300-hp. single-geared motor, axle hung and spring-nose suspended on the truck transom. The truck pedestals carry removable shoes so that wheels and axles may be dropped without disturbing the traction motor. This is done by suspending the motor from lugs on the underside of the cab frame, removing pedestal binders and motor axle caps, dropping shoes and then moving the wheel and axle assembly far enough to one side to clear the motor suspension bearings. The entire assembly can then be dropped, leaving the motor in place. If desired, the traction motor may be removed through a drop pit without untrucking, since removal of the pedestal shoes permits moving the axle far enough to one side for the motor to clear the safety lugs on the truck transom. For hub liner removal, the entire journal box can be pulled off the end of the axle without disturbing the wheels, by blocking the semi-elliptic springs and removing the pedestal shoes. These features facilitate maintenance operations, saving time and money.

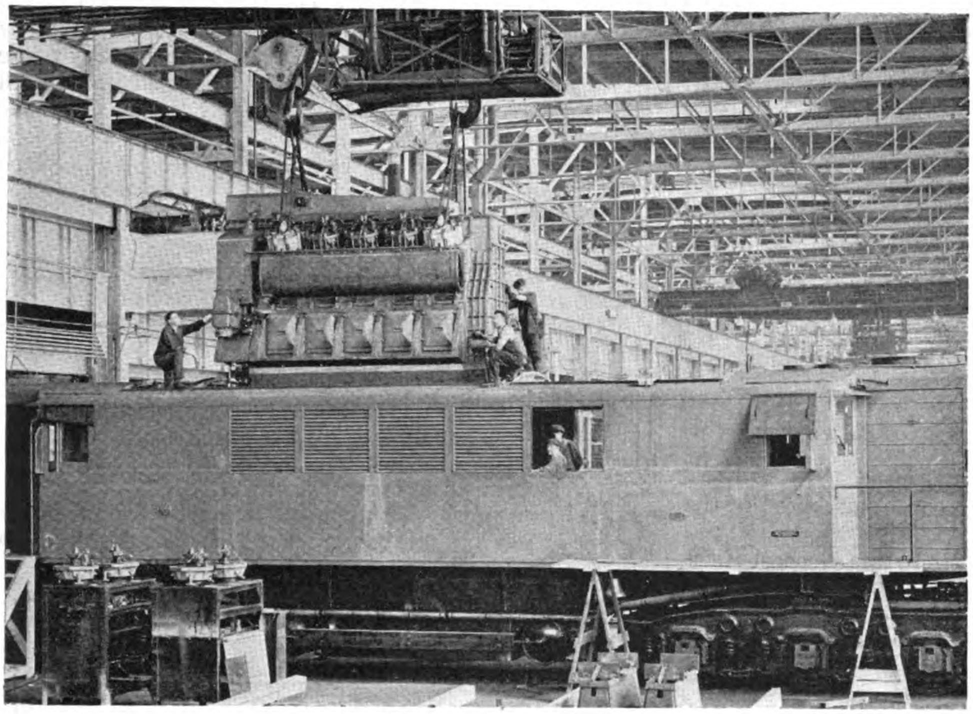
Renewable spring steel liners are provided on journal boxes, pedestal shoes, center plates and side bearings. Case hardened pins and renewable bushings are used in all important points in the brake rigging as well as in all equalizer and spring hanger bearings.



Tractive-force-speed curve

Principal Dimensions of I. C. 2000-Hp. Diesel-Electric Switcher

Length over couplers	60 ft.
Total wheelbase	48 ft.
Rigid wheelbase	11 ft.
Wheel diameter	39 in.
Driving-motor gear ratio	62 to 15
Weights:	
Mechanical portion	144,800 lb.
Engine and accessories	84,300 lb.
Electric transmission and auxiliaries	99,600 lb.
Locomotive, light	328,700 lb.
Locomotive, ready to run	346,000 lb.
Total weight per axle (six)	57,700 lb.
Weight of bare engine	72,000 lb.
Engine weight per brake hp.	36 lb.
Locomotive ratings:	
Continuous tractive force	36,500 lb.
Speed at continuous rating	16.5 m.p.h.
Tractive force, 25 per cent coef. of adhesion	86,500 lb.
Maximum speed	60.0 m.p.h.
Diesel-engine rating and dimensions:	
Continuous rating Busch-Sulzer two-cycle, V-10 engine	2,000 brake hp.
Normal engine speed	550 r.p.m.
Idling speed	275 r.p.m.
Cylinder bore and stroke	14 in. by 16 in.
Crank-pin bearing diameter	14 in.
Brake M.E.P. at 2,000-hp. rating	58.46 lb. per sq. in.
Air compressor displacement (2 comp.)	200 cu. ft. per min.
Fuel tank capacity	1,200 gal.



Lowering the 10-cylinder engine into the cab during construction

The problem of underframe design, with the deflection held to an acceptable value without getting into excessive weight, presented some difficulties, since the engine-generator set alone weighs over 50 tons, and has to be supported on the underframe midway between centerplates 37 ft. 4 in. apart. Only by fabricating the structure was it possible to meet weight restrictions and still secure sufficient stiffness. The success of the design developed is shown by the fact that the total deflection was approximately 3/8 in. at the center, with a bending moment of 11,000,000 ft.-lb., maximum calculated stress being 10,600 lb. per sq. in.

The underframe is 56 ft. 8 in. long and carries a total weight of 219,200 lb. on the two centerplates. The underframe is constructed around the two main longitudinal members which run the entire length, the engine-generator set being mounted direct on them over the middle opening. These members are fabricated from H beams 29 7/8 in. deep, weighing 172 lb. per ft. For 17 ft. 10 in. at the middle of the platform, the original beam section is maintained. Then the beams are tapered to a depth of 18 3/8 in. at each center plate, this section continuing toward the ends for 2 ft. 9 1/2 in., then tapering again until they reach a depth of 4 in, at each end. The two beams are fastened together at each centerplate by a bolster consisting of a heavy top plate, two reinforcing transverse H beams and the main body bolster casting. Further lateral stiffening is provided by cross-tie members made of H beams and channels. The tops of the beams are covered by 1/4-in. and 3/16-in. plates which form the cab floor. This entire assembly is electric welded into a composite whole in which the material has been utilized to better advantage than possible by any other available method of manufacture.

The cab is a box type with radiator assemblies ahead of an operating compartment at each end, the engine room occupying the mid portion. The cab structure is built up directly on the main underframe just described. The side and roof sheets which are respectively 0.109 in. and 0.172 in. copper bearing steel, are electrically spot and line welded to stiffening members, giving a perfectly smooth exterior of pleasing appearance.

The sand boxes, one in each front corner post of the radiator compartments, are filled from the platform. The water and fuel-oil filling connections are reached from the ground. The main lubricating oil system is filled from either end through connections on the corner of the roof and accessible from the steps on the side of each radiator compartment.

Equipment Accessibly Located

The equipment layout is characterized by accessibility and ease of maintenance. The engine-generator set occupies the greater portion of the central compartment, with control and air brake equipment, engine auxiliaries and traction motor blower sets disposed at each end.

Three hatches are provided for taking out engine, generator or other heavy equipment. The top of the engine is made accessible for cylinder head or piston removal by taking off the main hatch cover. Fuel pumps, governor, servo-motors, etc., are located at the free end of the engine and can be worked on from the aisle by removing suitable covers on the end housing. All piping located below the false floor is made accessible by removable flooring; and valves, if covered, are reached through trap doors. Only certain piping and wiring is carried below the floor level, no apparatus being located where it is not readily accessible from the aisles, with the exception of the lower brush-holders of the main and auxiliary generators, which can be reached through suitably located hinged doors.

A lubricating oil tank is located in each radiator compartment (at ends of the locomotive), being mounted inside the tripod supporting the vertical fan motor. Each of the aphonic-type fans exhausts 57,000 cu. ft. of air per minute through the cone which forms the inner wall of the water tank. At the right, behind the tripod, the door into the operating cab can be seen. At the left is the motor-driven fan on the fin-tube hot water heater which heats the operating cab, as well as the duct for recirculating this air.

The battery, consisting of 56 cells of MVMHT-21,340 amp.-hr. capacity, is mounted in two compartments in the sides of the main girders of the underframe, and is serviced conveniently from the ground. The 1200-gal. fuel tank is of welded construction and is suspended from the cab underframe.

This arrangement, as contrasted with a built-in tank

integral with the underframe structure, avoids the difficulties of keeping the tank tight in spite of underframe deflection and weaving.

The air reservoirs also are suspended underneath, which puts them at the lowest point in the air brake system. This is desirable since it tends to keep water out of the other equipment.

With a view to minimizing maintenance costs, all apparatus is located not easy accessibility in place but also for easy installation or removal.

The Electric Transmission Equipment

The Diesel engine is direct connected through a flexible coupling to the generator, which is the largest traction-type unit yet built. This machine consists of a main and an auxiliary generator, the overhung auxiliary generator armature being mounted on an extension of the main generator shaft beyond the single anti-friction bearing. The engine end of the main generator armature is supported by the coupling. The entire set is longitudinally ventilated by a fan mounted on the coupling end armature head.

The main generator is a 14-pole machine converting an average engine output of 1,930-hp. to traction motor input at a maximum efficiency of 94.4 per cent. Over the entire load range, the efficiency is said to be never less than 93 per cent. The weight of the machine is 18,000 lb. or 9.3 lb. per input hp. at 550 r.p.m.

The traction motor equipment consists of 6 GE-716 single-geared motors, each forced ventilated with 1,500 cu. ft. of air per minute through ducts in the cab underframe and a sliding plate connection. The maximum reduction gearing of 15 to 62 actually permits a maximum locomotive speed of 64 m.p.h. corresponding to 2,280 armature r.p.m., although the maximum permissible speed is nominally 60 m.p.h.

The speed-tractive effort characteristics of the locomotive are the following points:

1. The maximum tractive effort of 100,000 lb., assuring ability to start any train encountered in this service.
2. Continuous rating of 36,500 lb. tractive effort at 16.5 m.p.h., assuring ample electrical capacity.
3. Full Diesel-engine horsepower utilization up to 48 m.p.h., assuring maximum performance of the locomotive for transfer service over a wide range of speed.
4. Transmission efficiency of about 82 per cent to 86 per cent from 15 m.p.h. to 48 m.p.h.

Constant engine horsepower is maintained over a wide range of locomotive speed for transfer service (48 m.p.h. maximum) by a combined exciter and pilot generator belted to the shaft of the main unit and mounted above the auxiliary generator.

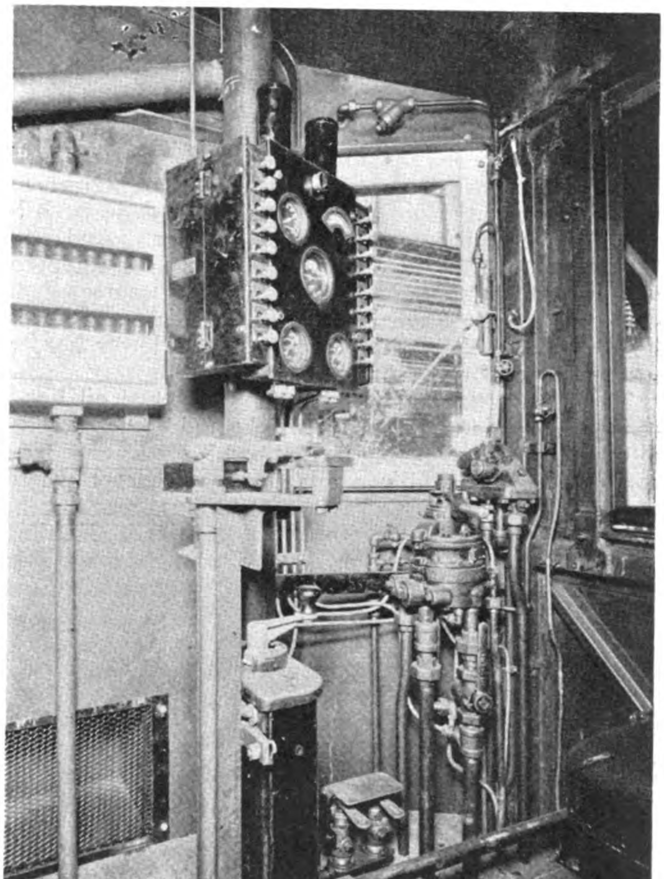
The traction motor control is handled with standard electro-pneumatic contactors and reversers. The locomotive speed is controlled by a combination of Diesel engine speed and traction motor combinations. At each engineer's position are a throttle handle and a controller. The former is connected mechanically to the engine governor. Its position determines the Diesel engine speed in the conventional way. The position of the latter determines the direction of motion of the locomotive. With the controller handle in the high speed notch before the locomotive is started, the motor connections listed above are obtained automatically, and transitions made at the correct speeds as the locomotive accelerates, terminating in the parallel, shunted field connection. This assures maximum locomotive performance and relieves the engineer of the necessity of manipulating the controller handle at each transition.

Excellent visibility is obtained from the engineer's position. Duplate safety glass is used in all doors and windows. The interior of the cab is lined with Silento felt for both heat and sound insulation. The warm radiator compartment on one side, the large air blast hot water heater with re-circulating duct, and insulation assure a comfortable cab even in the severest winter weather in Chicago.

Auxiliaries — Cooling System

The entire auxiliary system is designed for continuous operation at full output regardless of Diesel-engine speed within its operating range. For reliable and satisfactory performance of water cooling equipment, motor ventilation system, battery and compressors, a locomotive designed for long transfer runs or road service needs this.

The auxiliary generator, which is part of the main generating set, as mentioned before, has its voltage held constant over the entire operating range of Diesel-engine speed. The auxiliaries, driven from this source of power, are as follows: "Two 100-cu. ft. (each) displacement two-stage air compressors; two radiator blower sets; two traction motor blower sets; one water heater blower



The operator's control station

and ignition set; and two operating cab heater blower sets. In addition to these, battery charge and power for control and lighting is taken from the constant voltage source.

The engine cooling system was designed to insure sufficient capacity for continuous operation at full horsepower during the hottest weather encountered in Chicago. The Diesel engine has two water circulating pumps, one for each bank of cylinders, and two lubricating oil pumps. One scavenges the engine sump, delivering the oil through filter and radiator to the storage tanks; the other delivers oil under pressure from the storage tanks to the engine bearings. The locomotive has two identical radiator assemblies, one at each end of the cab. The front and one side of each assembly pro-

vides the water radiation, and the other side takes care of the lubricating oil. The water radiators in each end are connected in series with the two pumps on the engine; that is, the entire water system is in series. This insures equalized water temperatures within close limits throughout the whole system. The oil radiators in each end are connected in parallel. Because the engine has two lubricating oil pumps, low pressure sections can be used in the oil radiator, and are duplicates of the water sections.

A feature of the radiator design is the three sided construction providing a large surface exposed to outside air, with the ventilating fan so arranged that almost uniform velocity is maintained throughout the complete air path. This results in obtaining the required cooling with a relatively low fan horsepower. The aphonic type fan is of high efficiency and is surprisingly quiet. The latter feature is very important on an installation of this kind because of the tremendous amount of air handled. The two blowers deliver approximately four tons of air a minute (114,000 cu. ft.) through the radiators.

Series-parallel control of the two motors gives desirable flexibility by permitting economical use of the blowers for a given condition of operation and makes it easier to hold the water temperature within close limits without frequent starting and stopping of the fans. In order to provide the radiating system with greater flexibility for seasonal temperature changes, semi-permanent winter covers are supplied for covering whole or half sides of the radiator during cold weather. And still further, one entire side of each water radiator is equipped with adjustable shutters. The radiator is composed of sections bolted to headers. The intermediate and lower headers are of the floating type with the lower header resting on supporting springs.

Throughout the water, lubricating and fuel oil lines, copper tubing is used, saving weight and space, making a more accessible piping layout, and preventing pipe corrosion. Sweat fittings are employed except where unions are necessary to remove apparatus, resulting in an exceptionally tight piping installation. Flexible metallic joints are used for air and steam connections between cab and trucks, a steam line being installed for eventual use with heater trailers.

Car Wheel Company Enjoys Unusual Distinction

Few manufacturing companies in this country can boast of a continued existence of over 100 years, and possibly only one of having existed for so long a period under the leadership of three men of two generations—a father and two sons. The Lobdell Car Wheel Company, Wilmington, Del., bears this distinction. Its beginnings go back well beyond the period when George G. Lobdell, Sr., was placed in charge of the foundries and machine shops in the summer of 1836.

Some time prior to 1830 Jonathan Bonney, an experienced founder and iron worker, came to Wilmington, Del., established an iron foundry and commenced the manufacture of car wheels. The Baltimore & Ohio Railroad had just been started. About 1830 Mr. Bonney entered into a partnership with Charles Bush, under the name of Bonney & Bush and built a new foundry and machine shop, which had a production of 10 car wheels a day. In 1832 George G. Lobdell, Sr., a nephew of Mr. Bonney, who had been left an orphan at the age of 14, came from Kingston, Mass., to live with his uncle, working as an apprentice in the shop.

In the summer of 1836, while Mr. Bonney was away from Wilmington, the foreman of the shop became ill and Mr. Bush, who was not a practical man, sent word to Mr. Bonney, asking for advice as to what he should do. The word came back, "Put George in charge," and so George G. Lobdell, Sr., at 18 years of age, was placed in charge of the foundry and machine shops. Mr. Bonney died in 1838 and Mr. Lobdell assumed his interest in the partnership, which continued until 1859 under the firm name of Bush & Lobdell.

Mr. Lobdell had shown a special interest in improving the foundry practices and on March 17, 1838, patent 637 was issued to Jonathan Bonney, Charles Bush and George G. Lobdell, covering a wheel of double plate design; the two plates bellied outwardly and extended from the tread to the hub. This design was in successful use for a number of years.

The business expanded so rapidly that in 1844 a new plant was built on the banks of the river, so that raw materials could be unloaded from vessels at its own wharf; this also facilitated direct shipments for export. The capacity of this plant was 150 wheels a day. The foundry was destroyed by fire in 1853 and was replaced with a new one, with a capacity of 200 wheels a day. Mr. Bush died in 1855 and the business was continued by his sons and Mr. Lobdell until 1859, when the latter acquired complete control, operating under his own name.

In 1867 the plant was incorporated under the name of Lobdell Car Wheel Tire & Machine Company, with Mr. Lobdell as president, and William W. Lobdell, his elder son, as secretary. The capacity of the plant was increased to 250 wheels a day. The corporate title of the company was shortened to its present form, Lobdell Car Wheel Company, in 1871. The business had grown to such an extent by 1880, that a new plant was built on the present location, with a capacity of 500 wheels a day.

In 1888 the Master Car Builders' Association and the American Railway Master Mechanics' Association each appointed a committee to confer with representative car wheel manufacturers on the specifications of car wheels. The car wheel makers formed a temporary organization, known as the Association of Manufacturers of Chilled Car Wheels, and six of its members met with the railroad representatives. William W. Lobdell was made secretary of this joint committee, which then proceeded to draft specifications and tests for car wheels.

In 1891 William W. Lobdell secured a patent for an internal rib in the flange section to increase the depth of the chill in the throat, and in 1892 filed claims for a patent on a group of heat treating annealing pits, which could be brought to any desired temperature by passing hot gases through flues interspersed between the pits. This is said to be the real beginning of modern heat treating ovens.

George G. Lobdell, Sr., died in 1894 at the age of 77 years, and his son William W. Lobdell succeeded to the presidency; George L. Lobdell, Jr., the present president was made vice-president and treasurer. Twenty years later, in 1914, William W. Lobdell died and was succeeded as president by George G. Lobdell, Jr.

The present plant has a department for the manufacture of chilled iron rolls for various types of machinery and also for miscellaneous castings. The wheel department has two 84-in. cupolas, with a combined melting capacity of 50 tons an hour. President Lobdell is now in his 86th year, but seldom misses a day at his office.

In appreciation for and commemoration of the long and successful career of the Lobdell Car Wheel Company, the Association of Manufacturers of Chilled Car Wheels held its 29th annual meeting at Wilmington last May.

Link Motion Valve Gear

Part I

By J. Edgar Smith

Designing to achieve the best possible performance from this type of gear

So much has already been written regarding the correct method of laying out the Walschaert valve gear that any suggestion of just another method would be of little interest to the designer who is experienced enough to handle this type of work. But, any method that proposes a different approach to the problem by suggesting standards to be followed and recommends a method of determining these characteristics, should be of considerable interest, providing of course that the theory behind such a method is sound.

At this time, when there is a tendency to consider the possibility of using the poppet valve in place of the piston valve, it seems proper to review the merits and limitations of the piston valve and the Walschaert gear and set down a method of designing so as to achieve the best possible performance from this type of gear. This should not be done in the spirit of "clinging to the old" but rather with the idea in mind that from a clear understanding of the best it is possible to achieve with the present standard as a foundation, we are better able to verify the advantages of the poppet valve and discount its disadvantages.

It will be recalled that although the piston valve had been used to some extent previously, it became standard in 1910 when the superheater came into general use. Up to that time, the Stephenson gear had been adequate for the small saturated steam locomotives equipped with the "D" type slide valve.

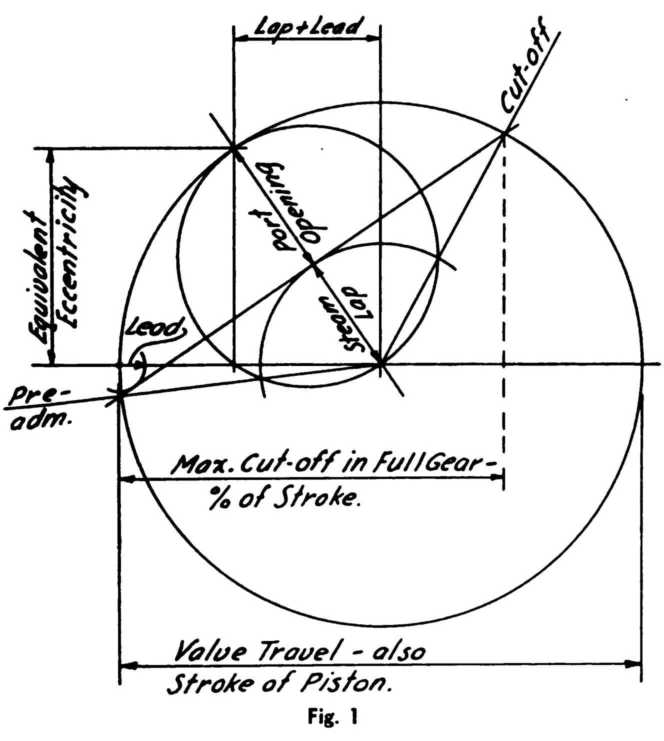


Fig. 1

The higher temperatures of the superheated steam made the acceptance of inside-admission piston valves a logical development. The inside-admission piston valve simplified the problem of valve-stem packings and reduced the frictional resistance of the valve itself. But, with the superheated steam came also higher steam pressures and the consequently greater piston thrusts which reflected through the entire structure of the locomotive. This all opened up the possibility of larger and more powerful locomotives and then greatly increased the sizes of the valve-gear parts. The inaccessability of the heavier eccentrics—located between the frames—paved the way for the acceptance of an "outside" gear.

Being an outside gear and due to its general design, the Walschaert gear has contributed much to the development of the modern locomotive. Its comparatively light parts and their accessability, and the ability to operate the heavier piston valves at higher speeds, has placed it in the position of preference over the Stephenson gear. It is, however, generally conceded that no improvement in steam distribution was accomplished when the slide valve and Stephenson gear were superseded by the piston valve and the Walschaert gear. And, even though the link motion types of gears generally do leave something to be desired in the way of efficiency, they are the only valve gears developed up to the present time that have demonstrated the ability to stand up to the severe requirements of modern locomotive service, particularly in this country, where long runs at high sustained speeds and intensive use of the motive power are common practice. High speed is the crucial test of any valve gear.

In passing, reference should be made to the Baker valve gear. While this is not a radial-link-motion gear, in the strictest sense, the same effect is accomplished by a system of bell cranks and levers as is done by the sliding block and radial link of the Walschaert gear and it may therefore be considered under the same general classification. Like the Walschaert gear, it has stood the test of present day requirements. With the same travel, steam lap and lead there is practically no difference in the movement derived from either gear, although the Baker gear has greater travel capacity. This capacity alone has had much to do with the popularity of the Baker gear since the introduction of the limited-cutoff feature.

The adoption of the limited-cutoff feature to the design of cylinders, the consequent still higher boiler pressures, larger diameters and greater port areas, made necessary still larger piston valves, wider ports and longer valve travels. The increased speed required of the present-day passenger, as well as freight types of locomotives, has brought us to what is believed to be the limit of the possibilities of the present standard valves and valve gears. We are now at a point in the development of the art of locomotive design where something more than just increasing the size of the

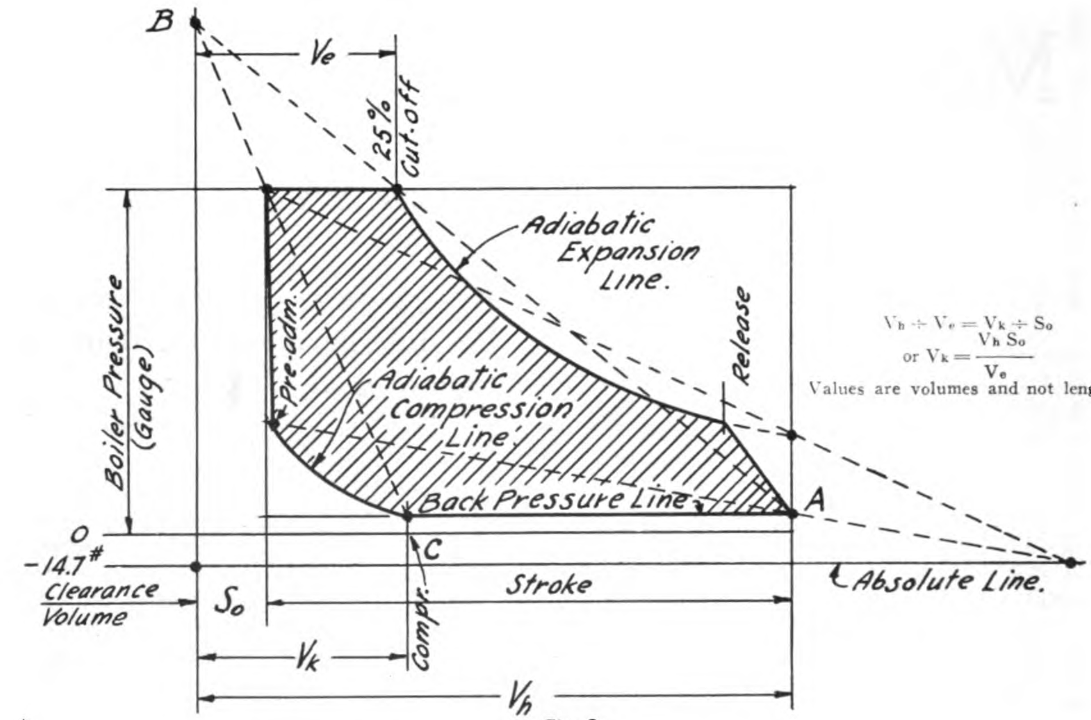


Fig. 2

$V_h \div V_e = V_k \div S_o$

or $V_k = \dfrac{V_h S_o}{V_e}$

Values are volumes and not lengths.

piston valves and increasing the size and strength of the valve gear parts may be necessary. These details already have reached such proportions as to require so much power to overcome their own inertia, that it is evident future development may have to be in another direction.

A few railroads in this country are now experimenting with poppet valves in the hope that they will furnish the solution to the problem. But, before attempting a study of the different types of valve gears in use today for operating poppet valves and consideration of the improvements necessary for the realization of all the advantages of the poppet valve, it appears logical to analyse first the present standard piston valve and the Walschaert valve gear with the idea of designing to achieve the best possible performance of the locomotive from this type of gear.

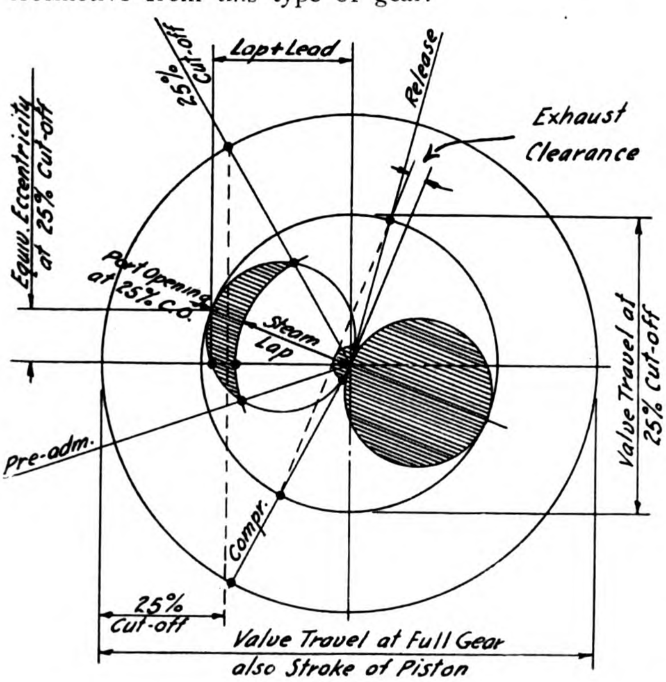


Fig. 3

For actually laying out the Walschaert gear there is little difference in the various methods used. Some designers prefer to calculate the lengths and proportions of all the members. Others depend entirely upon

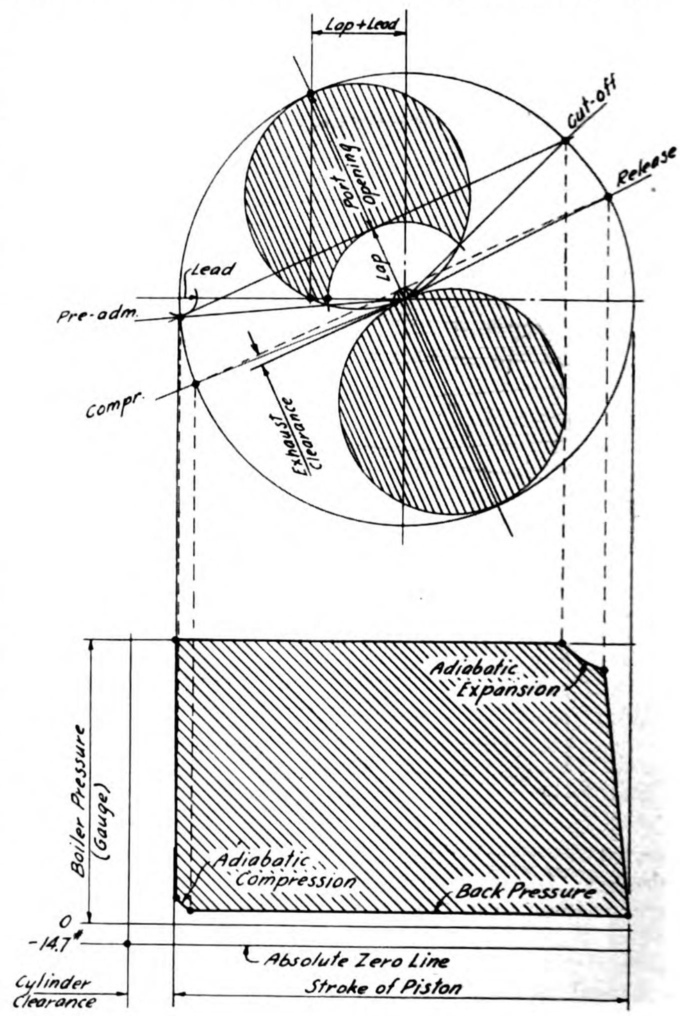


Fig. 4

the layout. In either case, the layout is based on given valve characteristics.

When something more than just a valve gear layout to meet certain valve events is required, i.e., a design of a valve gear to meet certain operating conditions, the problem takes on an entirely different aspect. For the designer who has had a wealth of experience with all types of locomotives which are operating under all the many different conditions of service and has at hand actual indicator cards taken from the cylinders operated by valve gears which he has designed, the problem of determining the valve events for the locomotive under consideration is comparatively simple.

Selecting the Valve Events

Unfortunately, many who are called upon to design Walschaert valve gears, have not had this experience and consequently must refer to published Standard Valve Settings. Also, very little has been published to date regarding recommended valve settings for valve travels over 7 in., and even those published recommend events for standard locomotives operating under average conditions. Therefore, in order that the designer may determine the proper valve events to be provided for in the design of the locomotive he has under consideration, the following method is suggested. Instead of arbitrarily selecting the valve travel, lap, lead and exhaust lap (or clearance), it is recommended that only the following be selected:

Valve Travel—From 8-in. to 8½-in. travel is about the practical limit of the Walschaert gear. The 8-in. travel will give good results for passenger locomotives, while the 8½-in. travel may be used for freight locomotives, providing the general proportions of the locomotive are such that the limiting angles of swing and limiting proportions of levers are not exceeded. In that case, it may be necessary to drop back to 8¼-in. travel or even to 8-in. In either case, with a valve travel of from 8 in. to 8½ in., the longest steam lap possible will be obtained for the class of service under consideration.

Cutoff—Since too late maximum cutoffs in full gear intensify the problem of getting rid of the steam properly—especially in passenger locomotives—and lessen the economy of the performance, there is little object in holding to the mistaken idea of the necessity of real long cutoffs. A cutoff of 85 per cent is sufficient to produce the rated tractive force of the locomotive and need not be exceeded. However, if the weight of the locomotive will be sufficient to maintain a liberal factor of adhesion and it is desired to favor the starting power at the expense of a trifle less economy, the maximum cutoff in full gear for freight locomotives, which will be required to start heavy trains frequently, may be set at 88 per cent.

Lead—The lead, which is only the width of port opening at the beginning of the stroke, is, contrary to the general impression, of no great importance except that it, in combination with the valve travel and lap, contributes to the port opening at short cutoffs. The longer leads produce greater port openings and therefore the longest lead is given to passenger locomotives,

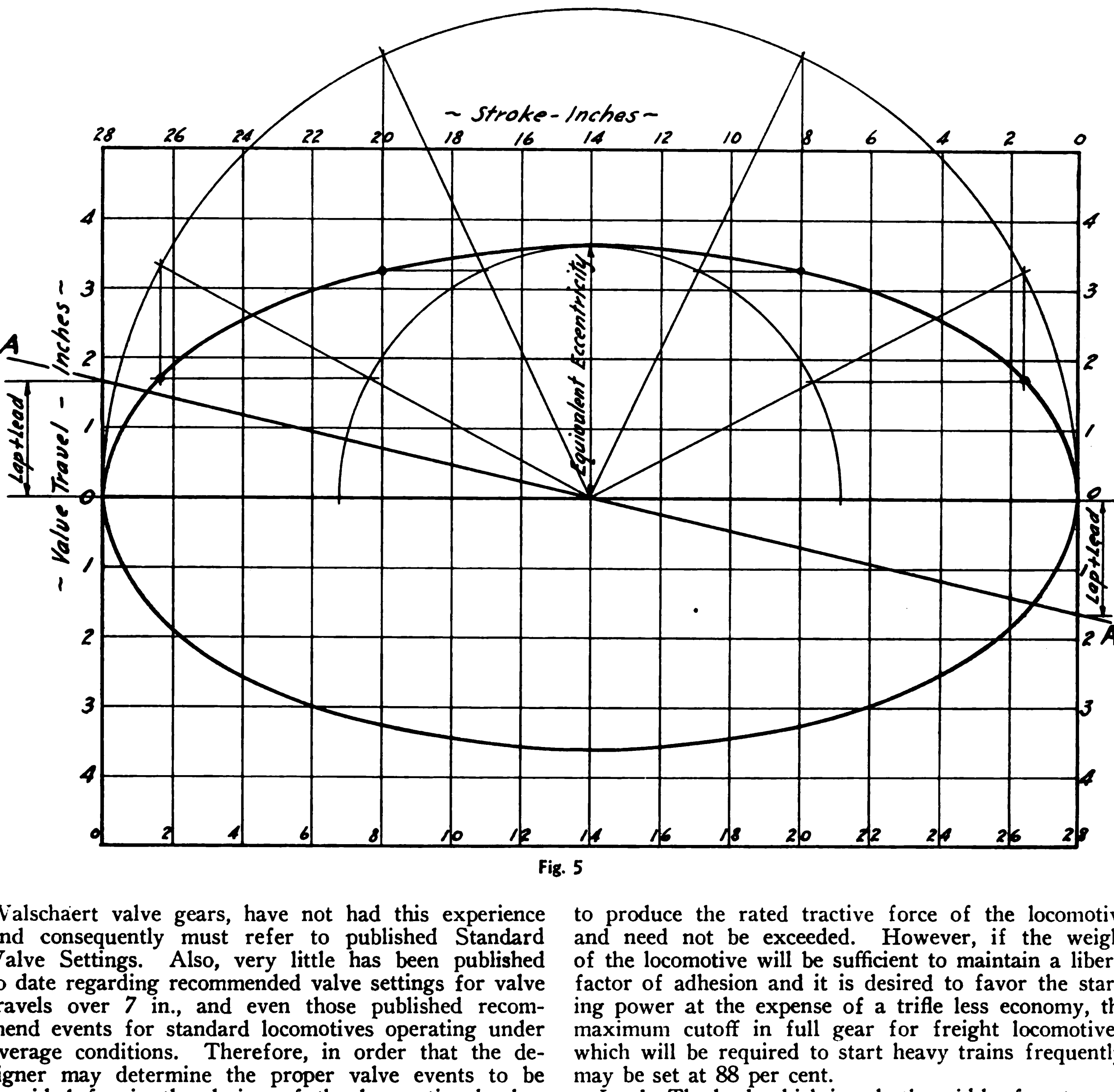


Fig. 5

in order that the greater port openings at the short cutoffs will be available for producing the horsepower necessary to propel the locomotive at the higher speeds. The standard leads are as follows:

Lead	Service
5/16 in.	Fast passenger
1/4 in.	Passenger
1/4 in.	Fast freight
3/16 in.	Freight
1/8 in.	Switching

With these important events decided upon, viz., the valve travel, maximum cutoff in full gear and the lead, the lap, equivalent eccentricity and pre-admission can be determined by laying out a Zeuner diagram as in Fig. 1.

Steam Lap—Contrary to the general opinion, the steam lap is of no greater importance than the other steam events. For a given valve travel, lead and maximum cutoff, the lap can be but one width. The lap does have a direct influence on the amount of port opening, which is of great importance, but any increase in lap can only be accomplished by either shortening the maxium cutoff, shortening the lead or increasing the travel.

Pre-admission—Like the cutoff, pre-admission is the effect of the travel, lap and lead. At full gear the pre-admission is unimportant providing the lead is correct and at the short cutoffs the pre-admission increases proportionately.

Lap Plus Lead—In the Zeuner diagram the lap plus lead represents the motion derived from the combination lever alone.

Equivalent Eccentricity—In the Zeuner diagram the equivalent eccentricity represents the motion derived from the link alone.

Selecting the Exhaust Events

The selection of the proper exhaust events is equally as important as that of determining the steam events. While it is true that with the piston valve and the Walschaert gear there is a fixed relation between all the events, throughout the full range of cutoffs under any given set of conditions, it is possible to determine at what point in the stroke the compression should be set to approach, as nearly as possible, the theoretically perfect cycle of events. This point, however, should be selected as a means of determining the proper exhaust lap (or clearance), rather than as the result of selecting an exhaust lap (or clearance).

Prof. Stumpf has developed a method, which may be plotted graphically or calculated from the formula given, for selecting the point of compression, based upon such characteristics as cylinder volume, clearance volume, working pressure and back pressure. This method was the result of a study of the losses due to excessive cylinder clearance volumes, particularly with reference to the Unaflow cylinder. However, the same principles are involved in the study of the losses due to excessive cylinder clearance volumes in the multi-flow cylinder. Unquestionably, any method that will aid correctly in the selection of the proper point of compression for the Unaflow cylinder will apply equally as well to the multi-flow locomotive cylinder.

A study of actual indicator cards taken, at or near running cutoff, from locomotives which are known to operate smoothly and economically, will, when checked by this method, be found to hold surprisingly close to the proper point of compression thus found.

Running Cutoffs—Since, as stated above, there is

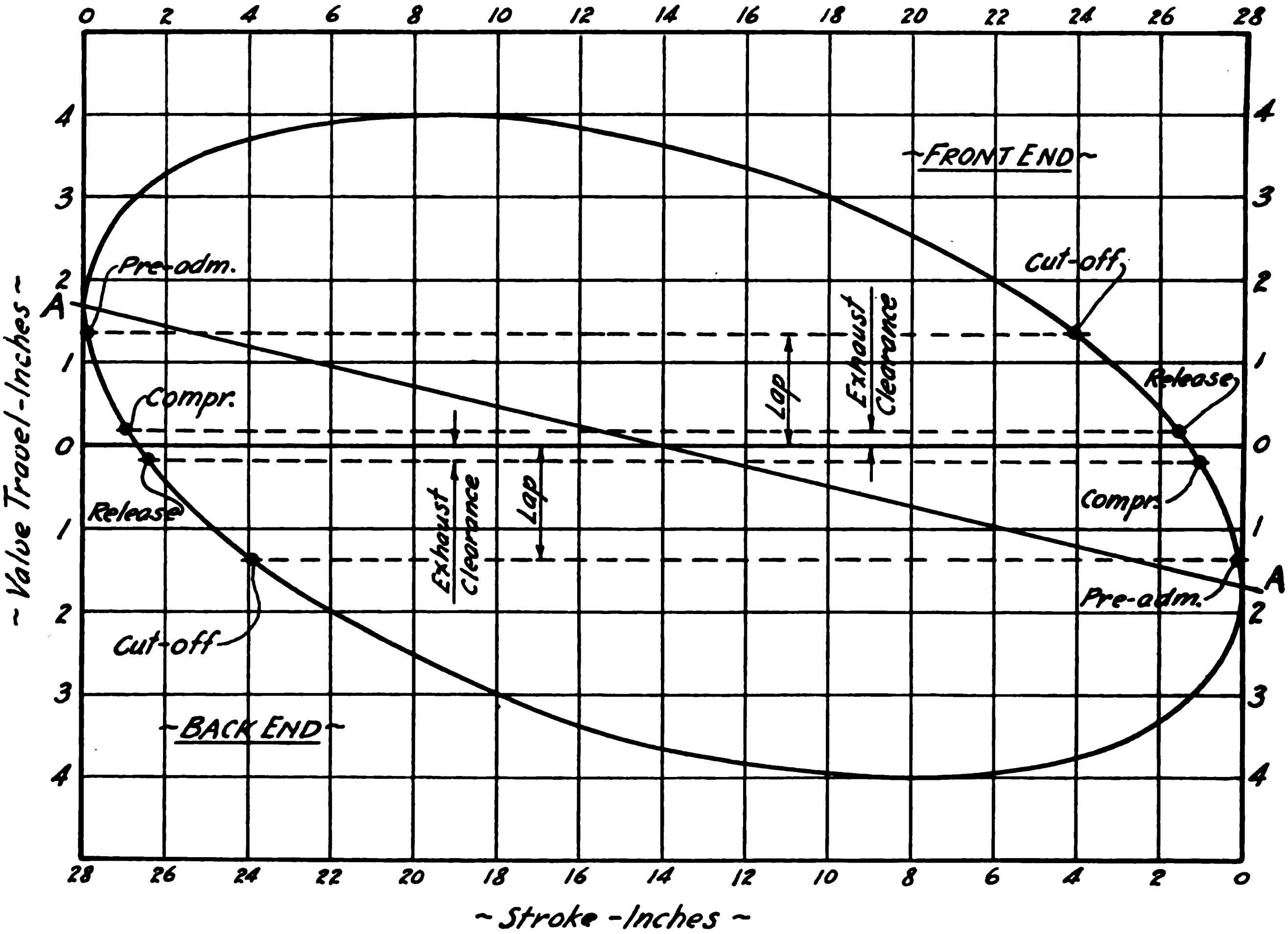


Fig. 6

a fixed relation between the steam and exhaust events as produced by the piston valve and the Walschaert gear, and which cannot be altered for the different cutoffs, the proper point of compression should be determined at running cutoff. Some variation is to be expected at full gear but we are concerned most with the economical performance of the locomotive at the cutoff at which it is used most for the longest periods of time and, therefore, our next concern is to determine the running cutoff for the locomotive under consideration. Briefly, we may be guided by the following running cutoffs for locomotives in the classes of service shown:

Cutoff	Service
25 per cent	Fast passenger
25 per cent	Passenger
33 per cent	Fast freight
50 per cent	Freight
66 per cent	Switching

Determining the Proper Point of Compression

Having selected the running cutoff, the proper point of compression may be found by either the graphical method shown in Fig. 2 or by use of the formula accompanying it.

Determining Release and Exhaust Lap (or Clearance)

With the maximum valve travel, lead, and lap as found in Fig. 1, this Zeuner diagram, Fig. 3, can be constructed for 25 per cent (running) cutoff. By laying off the point of compression as found in Fig. 2 and completing the diagram, the point of release and the exhaust clearance (as occurs in the example shown) can be determined.

Theoretical Indicator Card

With the exhaust clearance as found in Fig. 3, the completed Zeuner diagram and theoretical indicator card can then be drawn as in Fig. 4.

Theoretical Valve Ellipse

Before calculating the actual lever proportions necessary to produce the desired valve events, the characteristics obtained by the Zeuner diagram may be used to construct theoretical valve ellipses, as well as theoretical indicator cards. Since the valve ellipse represents the combined effect of the motion produced by the combination lever and link, it is necessary to analyse first the motion produced by each, separately, and then combine them to produce the valve ellipse. Referring again to Fig. 1, the lap plus lead represents the motion produced by the combination lever alone and the equivalent eccentricity represents the motion produced by the link alone. The valve travel is a combination of these two motions.

It is advisable to lay out a valve ellipse blank to the same scale as that usually used in connection with a valve gear model. As in Fig. 5, line A-A will represent the motion produced by the combination lever alone. In order to plot the motion produced by the link alone, an ellipse may be constructed geometrically, using the stroke of the piston as the major axis and the equivalent eccentricity as the semi-minor axis.

By combining the motions represented in Fig. 5, as A-A and the ellipse, the combined ellipse constructed about axis A-A, as in Fig. 6, will represent the theoretical valve ellipse. While this theoretical valve ellipse will not be exactly as would be taken from a valve gear model, it will be just as accurate to use for comparing the valve performance of one locomotive with another as the theoretical indicator card is for comparing the cylinder performance of one locomotive with another. By the same method as just described and with the equivalent eccentricity at running cutoff as found in Fig. 3, the theoretical valve ellipse for running cutoff may be plotted.

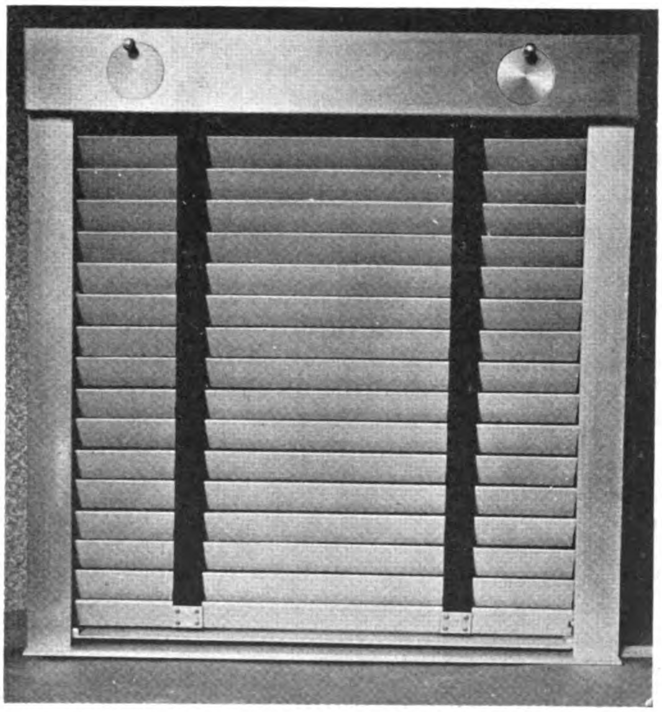
(To be continued)

Metlvane Blind For Passenger Cars

An aluminum-slat blind, recently placed on the market by H. B. Dodge & Company, Chicago, is designed especially for use in railway passenger cars. It is similar in principle to the popular Venetian blind successfully used in homes and offices. It is attractive in appearance and noise-proof in construction.

Doubtless the most important feature of the Metlvane Blind, as it is called, is its control of light. By shutting out direct rays, it eliminates shadows and contrasts and distributes a soft, uniform light throughout the entire car. With the slats tilted at the proper angle, a passenger may sit with complete comfort in any seat and enjoy a relatively unobstructed view outside. Likewise the blind provides complete privacy without shutting off the exterior view.

Beauty is merged with utility in the blind design. The horizontal aluminum slats preserve a streamline effect on both the interior and exterior of the car. Satin-finish



Metlvane blind operated by two small disc-type handles at the top

aluminum frames can be readily made an important element of the interior decorative treatment. Though distinctly modern in appearance, the blind fits well into any scheme of decoration.

Mechanically, the Metlvane Blind is a single unit built into a solid frame of extruded aluminum, which may be easily removed and replaced. All mechanism is concealed, and there are no apertures of any kind in the slats (as in the ordinary Venetian blind) to admit sun rays. The slats are constructed of an aluminum or stainless-steel covering over a thin strip of wood, which eliminates metallic ring. The slat ends are insulated with cast rubber capping to prevent rattle and vibration.

Even when the slats are tightly closed and set together, no noise from them is detectable in a train moving at any speed.

Two types of the blind are now being developed, each of which may be easily operated without effort or inconvenience. The first of these, illustrated, is operated by means of two small, revolving, disk-type handles built into the top fascia. One of the handles regulates the tilt of the slat, while the other controls the raising and lowering of the entire blind. A generous ratio of mechanical advantage assures easy operation in a minimum of time.

In the second type, not illustrated, raising and lowering of the slats in the side grooves is accomplished by means of a counterbalanced, self-locking bottom bar. By grasping the bottom bar, a passenger may readily raise or lower the blind to locked positions when up or down, which are really the only two correct positions to give maximum efficiency. The tilting device in this type consists of two small cords projecting from the side of the frame, at the fingertips of the passenger. Both types are of a simple, practical design which keeps original and upkeep cost at a minimum.

In cars, fitted with the customary type of window shades, the pocket of heated air present between the window pane and the drawn shade serves as a heat reservoir, detrimental to the comfort of passengers, even in air-conditioned cars, since this air cannot escape and be mixed with the treated air. The small spaces between slats in the new blind eliminate this closed pocket.

What Would You Have Done?

We have had a number of reactions in recent months to the little enginehouse drama which was presented in the *Railway Mechanical Engineer* of October, 1935, page 423. The S. M. P. took rather summary action in dealing with an infraction of the rules on the part of Bill Jones, the roundhouse foreman. A better handling of the case was suggested in our December number, page 517. Another communication was published in the February number, page 64.

Without understanding that more than one of their number had been asked to take over the assignment, several apprentices of the Grand Trunk Western at Battle Creek, Mich., were asked by the apprentice instructor to tell in writing what they would have done, had they been the S. M. P. Their reactions follow and speak highly for the discernment of these young men.

"Considering the good record of the workman and his ability, also the circumstances regarding the work at that time, I believe that the foreman used the best judgment in doing as he did. He was considering his responsibility in getting the engine out, since he realized there would be no excuse if he failed to have it ready for service. After hearing the explanation I would reinstate the foreman, after censuring him and the workman mentioned." —*Walter Venn.*

"I believe in all sincerity that the S. M. P. in this case acted impulsively without taking into consideration the foreman's past record. I would have asked for all particulars before drawing conclusions. The foreman had many merits, among them truthfulness and a desire to do his work well, as well as experience. It seems his only fault was an infraction of rules when he knew of no other means in order to accomplish his work. Therefore, I believe that a reprimand and not demotion would have been just punishment."—*Johnny Bond.*

"The circumstances of the case, as outlined in Scene III, seem to me to exonerate Bill Jones completely. His actions were those of any truly good foreman under the circumstances. He did not approve of the air-brake repairman's conduct, but he was sufficiently broadminded to realize that all humans must have their shortcomings and that the man's previous good record deserved some consideration. The man's services were necessary to carry out the superintendent's own instructions and a little common sense on the part of Bill Jones was the means of saving revenue, reputation and temper.

"The superintendent was plainly prejudicial in his condemnation of Bill Jones. He was determined to stamp out what he felt was a terrible condition, and all without endeavoring to understand the true situation. The day of 'tough guy' executives is gone. The man with the patience, courage and reasoning to be a leader, rather than a driver, is the man of true executive ability.

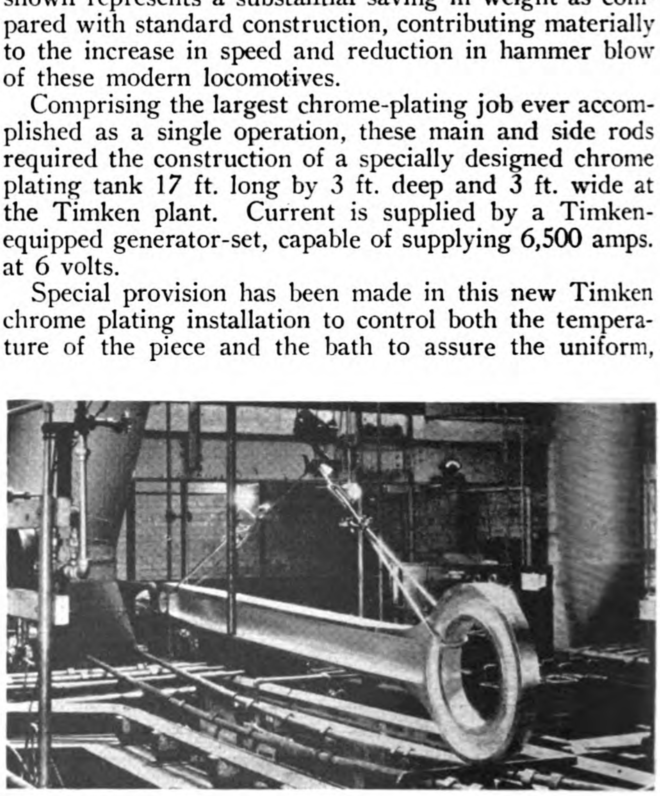
"In conclusion, let me say that had I been the S. M. P. I should certainly have fully apologized to Bill Jones for my hasty action and requested that he continue his duties as roundhouse foreman. Then, along with an honest effort to help him find a reasonable source of pride and pleasure in his position, I should have resolved to make myself a better, more understanding and less intimidating executive."—*Ernest Nightingale.*

Largest Chrome-Plated Locomotive Main Rod

The chrome-plated, heat-treated, alloy-steel locomotive main rod, illustrated, is one of a set consisting of two 12-ft. main rods and four 9-ft. side rods designed and built by the Timken Roller Bearing Company for use with their bearings on heavy duty, high speed steam passenger locomotives. Weighing only 510 lb., the rod shown represents a substantial saving in weight as compared with standard construction, contributing materially to the increase in speed and reduction in hammer blow of these modern locomotives.

Comprising the largest chrome-plating job ever accomplished as a single operation, these main and side rods required the construction of a specially designed chrome plating tank 17 ft. long by 3 ft. deep and 3 ft. wide at the Timken plant. Current is supplied by a Timken-equipped generator-set, capable of supplying 6,500 amps. at 6 volts.

Special provision has been made in this new Timken chrome plating installation to control both the temperature of the piece and the bath to assure the uniform,



Chromium-plated main rod designed for heavy service, weighing only 510 lb.

dense coating required to withstand the severe conditions to which locomotive parts are exposed.

A 7½-hp. exhaust system, capable of handling 12,000 cu. ft. of air per min., was installed in connection with this new tank and duplicated for the other tanks to eliminate the possibility of danger from the fumes. Provision is made in this installation to salvage chromic acid from the fumes by washing them as they pass through the exhaust system.

Clinchfield Rail Lubricator

After several years of experimentation and road service tests, a rail lubricator has been developed on the Clinchfield which seems to give highly satisfactory results. The device, which is applied to the rear truck of a locomotive tender, is operated over the Clinchfield line twice a day, once in each direction, thus oiling the tracks twice a day. Of the 276 miles of line, there are 118 miles of curves, 85 of which vary between 3 deg. and 14 deg. The oil consumption is 6½ gal. per mile of curves per month, and the cost is $0.94 per mile of curves per month. It is estimated that at least $30,000 a year is saved in the renewal of curve-worn rail alone. No attempt has been made to calculate the saving in flange-wear of wheels, but it is felt that the lubrication of rails on curves has caused a considerable decrease in flange wear as well as a decrease in number of derailments.

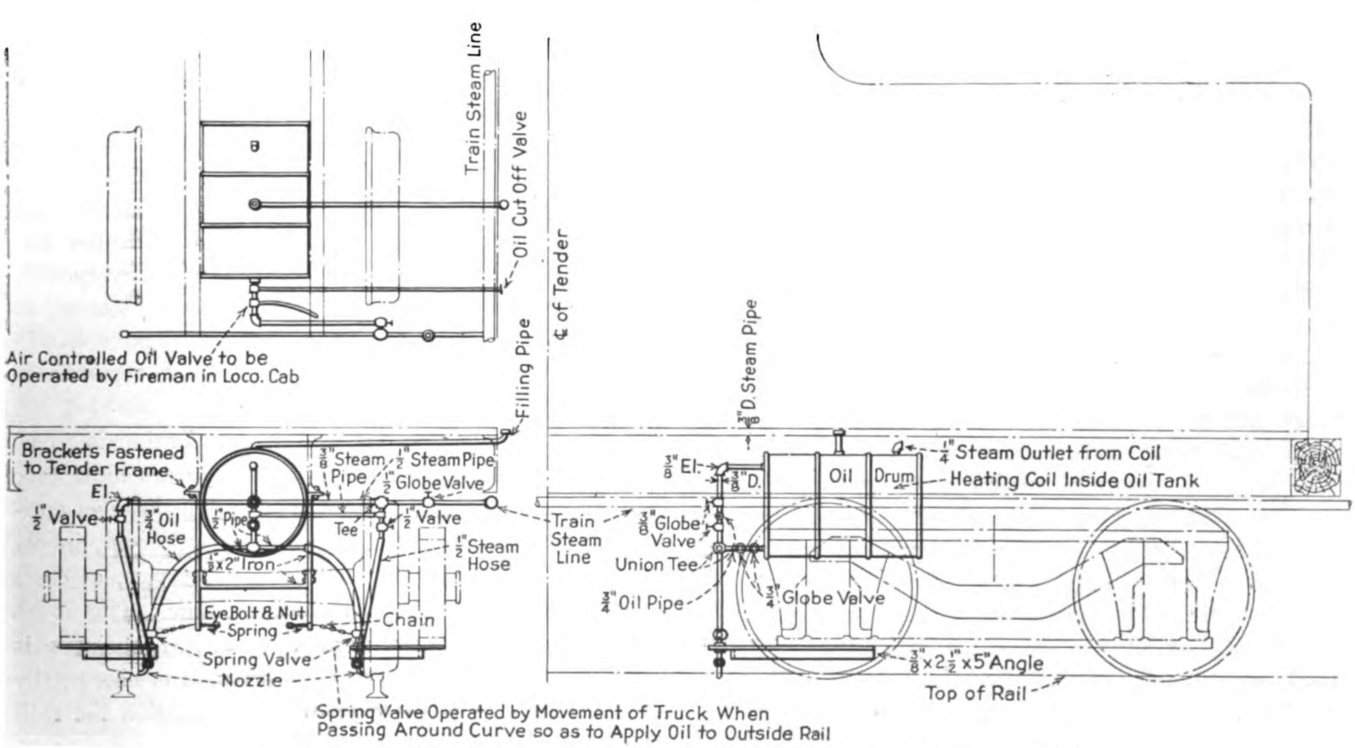
This device, as shown in the drawing, comprises an oil drum and pipes located under and fastened to the center sills, ahead of the rear truck of the locomotive tender. The drum is an ordinary metal oil barrel of about 50 gal. capacity. The oil is fed through pipes to nozzles located near the level of the top of the rail and directed at the inside of the rail head. A steam connection is also made at the nozzles. Near the nozzles are located self-closing spring valves in the oil line, arranged with chain connections so that when the truck swivels on a curve, the valve to the outside rail is opened and the steam jet deposits the oil on the rail. The nozzles and valves are fastened to the truck, and hose connections or flexible joints are applied in the steam and oil pipes to provide flexibility.

The present device is a gradual development from an earlier application which consisted of a drum of oil on top of a tender and valves manually operated by a section man located in a monkey box on the tank. So far as is known, the device is not patented.

The oil used in this rail lubricator consists of a heavy viscous oil thinned to the desired consistency. The successful operation of the device requires the sympathetic attention of both road and shop employees to see that the nozzles are kept in proper adjustment and condition.

The steam flow to the nozzle is controlled manually. The valves in the steam line are set to give the desired amount of steam and the steam blows continuously whether any oil is flowing or not. The spring valves, which cause the oil to flow when the truck swivels, are closed on tangents, opened a small amount on light curves, and opened wider on heavy curves. It is necessary to maintain a close adjustment of the nozzles to prevent an undue amount of oil being deposited on top of the rail. An inspection is made at the end of each trip, and if, as sometimes occurs, the oil gets on top of the rail, sanding is necessary to prevent driving wheels slipping.

The present device has been changed somewhat from that shown in the drawing by replacing the oil hose with a ½-in. pipe enclosed in a larger pipe to which side pipe connections have been welded. Steam to the nozzles is passed through the outside pipe thus forming a steam jacket for the inner oil pipe. With this arrangement, and the steam jet blowing all of the time, no trouble is experienced in using the device in sub-zero weather. As a further means of assuring reliable operation, a tee, located at the junction of the steam and oil lines, is equipped with a small nozzle forming a steam jet on the inside of the tee which provides a syphon action to assist the uniform flow of the oil when the spring valves are open.



Application of rail lubricator to the rear truck of a locomotive tender on the Clinchfield

EDITORIALS

Survival Of the Fittest

The machine age brought with it tremendous benefits but many difficult and preplexing problems. For one thing, it made possible the steam locomotive and the railroads. As a result, this vast continent with its almost unlimited natural resources, was opened up for development. The coming of the mass production era early in the present century and the more intensive applications of science and machinery to aggriculture, resulted in much higher standards of living and intensified the shifting of populations.

Progress in the development of our material resources has been further speeded up by the tendency in more recent years to intensify scientific research in almost every field of human endeavor. As a result we have seen the introduction of many new and novel products and the building up of a variety of new industries. Even the depression through which we have passed could not stop this tendency. One might have assumed that at such a time markets could be found for only the necessities of life. It is significant, however, that new products which cater to our comfort and convenience, and which in no sense are necessities, were introduced and successfully sold because of their novelty and the use of up-to-date merchandising methods in promoting their sale.

Most, if not all, of these new products and new industries come into direct competition with older established products and organizations. In the railroad field, for instance, we have witnessed the rapid growth and active competition on the part of the highway and airway carriers. The older industries ordinarily have the benefit of a sound financial structure, a well-trained personnel, and a successful background. On the other hand, the newer industries recruit their forces largely from among the younger men and move forward in a fighting spirit with energy and confidence, unhampered by traditions or inhibitions which sometimes exert a controlling influence in the older organizations.

In the field of transportation, the highway bus and truck and the aviation interests have been headed up by comparatively young men, with new ideas, up-to-date technical training and an understanding of the best merchandising practices. With more or less of a clean slate and open minds, and with little, if any, public regulation until recently, they have cut deeply into the railroad business. It was, of course, easier to do this than it would have been in the industrial field, because the railroads have been so closely regulated and controlled in all of their activities.

Moreover, the newer forms of transportation have been aided by government in the provision of highways and airways, whereas the railroads have had not only to provide expensive rights-of-way, but have had to pay heavy taxes on their valuation, these taxes going not to the promotion of transportation, but to help finance government. Fortunately, the Congress and the various state legislatures are awakening to the unfairness of allowing unregulated competitors to fight the railroads, which are so securely tied down by all sorts of regulation—federal, state and municipal.

In speaking at the Ninteenth Annual Conference on Industrial Relations at Silver Bay, N. Y., on current industrial problems arising out of transition from depression to prosperity conditions, Prof. Erwin H. Schell, head of the department of business and engineering administration of the Massachusetts Institute of Technology, emphasized the fact that the older industries must be keen to recognize and organize to meet competition from the newer industries, with their youthful personnel and energy. How is this to be done in the case of the railroads?

Obviously, the task must be approached from several angles. For one thing, every possible effort must be made to inform the public as to the facts about the railroads and their competitors, in order that they may all be treated alike, so far as regulation is concerned, and that no form of transportation shall be unfairly handicapped, as compared to the others. This is a matter that has received much consideration in recent years. In many places the railroad workers have been instrumental in forming strong railway employees' and taxpayers' organizations; the Association of American Railroads has recently embarked upon an ambitious public relations program, which promises to be effective in giving the general public a better understanding of the services which can be rendered by the railroads and of their problems and needs. These efforts are in the right direction and should receive the support and backing of every railroad employee, since it is directly to their interest, as well as that of the general public, to remove handicaps from the railroads and have them restored to prosperity.

In the next place, if this new competition is to be successfully met, the railroad managements must face the challenge with determination and make every effort to modernize the facilities and equipment, in order to provide the very best type of service, at costs low enough to be attractive to the public. This is no simple task, particularly at times when business is bad. In spite of difficulties, however, it is noteworthy that during the worst part of the depression the railroads started the movement to air condition their pas-

senger cars and to introduce the light, high-speed passenger trains. The very fact that the railroads had the nerve to undertake innovations of this kind under such conditions has made a most favorable impression on the public at large, and today they stand much higher in public estimation than they have for many years.

Passenger and freight services have been speeded up. Judging from the expressions from various elements of the traveling public, there is a need in many places for more frequent service. It would appear that the railroads have gone too far in cutting down some of their services and that there are possibilities of operating light, high-speed equipment at frequent intervals, which will help to regain business which has been lost to the private and common carrier automobile.

Improved schedules of this sort, however, will not be nearly as effective as they might be, unless railroad employees take a lesson from the highway and airway employees and render a larger degree of courtesy to the traveling public. One constantly is confronted with criticisms of grouchy railroad employees, in comparison to the courtesy and aggressively helpful attitude of the men who operate highway vehicles or the airplane services. If railroad employees would show the same interest in the traveling public and extend the same courtesies as the employees of these newer forms of transportation, a large amount of business would quickly return to the rails, and this applies to both passenger and freight services.

The mechanical department employee, who does not come in direct contact with the traveling public, cannot escape the fact that there are ways in which he can exert a helpful influence in improving conditions and lowering the costs of maintenance. Officers, supervisors and employees have grown old in the service and possibly have fallen into ruts. Have they kept abreast of developments, so that they can match the efforts of the younger group in the newer forms of transportation? Are they awake to the up-to-date improvements and operation of machinery and facilities, and are they keen to take advantage of new ideas? The art of supervision has become more or less of a science. It is true that nothing can replace common sense and the right sort of personality on the part of the supervisor, and yet there are ways of dealing with their associates and the workers that may be much more productive of results than those they are now using.

Are proper efforts being made to see that the older workers in the organization are carefully coached and trained so that they can handle the new equipment and tools properly and can improve their abilities and skills to meet present day demands? Railroad mechanical department officers have not thought over-much of training, even of apprentices, but many industries today are awakening to the fact that they have a responsibility for the continuous training of the workers throughout their service life. What is being done in your department in this respect?

The best young men should be recruited into the organization as rapidly as conditions will permit. This will help to average down the age of the organization and, if rightly selected and trained, these young men can be a large factor in improving the efficiency of operation in the years to come. Shall we be content with just ordinary, old-fashioned methods of recruiting and training apprentices, or shall we take advantage of the best thought and experience and develop apprentice training systems that will be most effective? It is significant that the railroads in the early part of the century, when the Santa Fe and the New York Central started their apprentice systems, were leaders in this respect in the entire industrial field. Can the same thing be said today?

If we are to meet successfully the new competitions, we must keep our organizations wide-awake and alert to take advantage of every factor that will help to improve the efficiency and economy of operation. Are we doing so?

Utilize the Experience Of Tool Makers

Not only is the machine equipment in many railway shops generally old and inadequate for the handling of work on a modern production basis, but some of the newer machines recently installed are limited in productive capacity by the failure to provide modern cutting tools, and particularly the necessary instructions regarding how to care for, grind, set up and operate these tools for the best results. In all of these particulars, railroad shop men will be well repaid in taking the trouble to familiarize themselves with the best practices in other railroad shops and also in industrial machine shops having extensive specialized experience.

This is particularly important since the advent and more general use of new metals in locomotive and car construction, including alloy steels, aluminum alloys and other special metals. Each of these materials brings its specific problems in satisfactory machining. Take, for example, the drilling and tapping of Alleghany steel and Monel metal. Great trouble has been experienced in performing these operations with what might be termed standard speeds. With drills ground with the standard commercial point, constant jimmying, jamming and breaking of the drill lips occurs and it has been found necessary to flatten the drill point, decrease the speed about 50 per cent below that generally used and complete the hole drilled without stopping.

Important questions regarding the size and type of cutting tool to use are constantly pressing for authoritative answer, as, for example, when to use formed vs. profile milling cutters, how to determine the rake and spiral necessary for the best cutter performance, when to use inserted blade or solid cutters, how to decide on hobbing vs. milling gear teeth, how to specify

the cutting feeds, speeds, lubricants and method of lubricant application which will produce the best results. Reaming holes for taper pins is another job which introduces complications unless reamers are provided having the correct general characteristics for each different type of job. Questions of how much power to provide and what machine adjustments can be made to prevent tool chatter are fundamental.

Too much stress cannot be laid on the importance of buying quality high-speed cutting tools, designed for their particular work, and then seeing that these tools are suitably cared for and properly ground for the different metals being cut. Most small tool manufacturers issue more or less comprehensive instructions regarding cutting feeds, speeds, etc., to be used with their tools in different materials. In the case of at least one manufacturer, this educational work is supplemented by the issuance from time to time of up-to-the-minute data sheets to be inserted in a loose-leaf engineering bulletin which represents years of experience and research in practically every phase of work that high-speed tools are called upon to perform. In addition, this company maintains an engineering inspection force qualified to analyze either ordinary or unusual machine-shop operations and offer valuable suggestions on improving work or increasing production.

One fact is quite evident. With the volume of machine-shop work now confronting railways in their effort to catch up on deferred maintenance of both cars and locomotives, no source of authoritative information and help in bringing small cutting tool equipment in railway shops up to standard should be overlooked. The extensive experience of the ablest tool experts of both the railways and the small tool manufacturers should be fully capitalized.

Familiarity Breeds Contempt

The well-known expression "Familiarity breeds contempt" is never truer than when applied to everyday operations in railway locomotive and car shops where, in the performance of many specific jobs, a certain element of danger exists unless unremitting care is taken to avoid it.

The article in the July *Railway Mechanical Engineer* pertaining to shop safety signs drew an interesting comment from a superintendent of motive power who says that the question of safety signs can be greatly overdone and that one or two signs, posted in a conspicuous place and changed frequently, seem to give better results. Moreover, the practice of having ten-minute safety meetings each Monday morning, at which the local shop or terminal supervisors review the performance for the past week and possibly describe in some detail the conditions leading up to specific accidents, has tended to revive and maintain interest in the important subject of safety.

The fact that long experience with repetitive operations involving some degree of danger may have a tendency to make shop men indifferent or careless was also referred to by this superintendent of motive power who writes as follows: "Some time ago, I made an analysis of our injuries according to the length of service of the employees and found that practically all of the injuries occurring were with employees of seven or more years' experience, indicating that, as the men become more accustomed to their work, they are inclined to be careless in handling it, and in my talk at various terminals on our railroad I have stressed that very point."

This statement illustrates only one of the many problems which aggressive safety committees at individual shops and terminals must keep constantly in mind and stress everlastingly if the desired results in accident prevention are to be obtained.

NEW BOOKS

AXLEBOXES AND RELATED PARTS, *Their Maintenance on Locomotives, Carriages and Wagons. By R. E. Brinkworth, A. M. I. Loco. E. Published by The Locomotive Publishing Co., Ltd., 3 Amen Corner, London, E. C. 4. 80 pages, 8½ in. by 11 in. Paper bound. Price, $1.50.*

This booklet, illustrated with drawings and sketches. sets forth the types of journal bearings, methods of spring suspension and wheels used on British locomotives and rolling stock. Its interest to the American reader lies in the extensive detail in which it goes into the performance and methods of service and maintenance of these parts according to British practice. Many details of construction and methods of lubrication which are foreign to American practice will be observed. There are seventeen chapters and an appendix. These deal with questions of lubrication and the treatment of hot boxes on the road, as well as the maintenance methods of dealing with each part.

HORSEPOWER OF LOCOMOTIVES—*Its Calculation and Measurement, By E. L. Diamond. Published by the Railway Gazette, 33 Tothill street, Westminster, S.W. 1, London, England. 24 pages, 9 in. by 12 in.; paper binding. Price 2s. 6d.*

This pamphlet is a reprint of a series of seven articles which appeared in the Railway Gazette in 1935. Starting with the early tests and deductions made by D. K. Clark, the author then takes up the work done by Prof. Goss, Von Borries and various investigators in America, England, Germany, France and other European countries. As test plant and road test data are the bases of our knowledge of locomotive horsepower —indicated, at rim of drivers and drawbar—consideration is given to such tests as those made by the Pennsylvania railroad and by other roads in Europe. In fact, the entire subject of locomotive testing is reviewed although somewhat briefly. The important formulas proposed by Cole and others are given, including the more recent formulas of Kiesel and Lipetz.

THE READER'S PAGE

Hiring and Firing Men

To the Editor:

On page 255 of the June issue of the *Railway Mechanical Engineer,* under the heading of "Firing Men," you publish a statement presumably written by a railroad official, reproducing a conversation with an applicant for employment.

I know the system of arbitrarily firing a man without a hearing still exists, but I still believe that each year there is an increase in the number of executives who are not too busy to give a discharged employee a hearing. If an official buys a piece of equipment or a machine and it does not come up to specifications, he will, in his report, elaborate on specific parts that are defective or inadequate; if the same official was compelled to give a similar report on the failure of his discharged employees and the discharged employees had the same opportunity as the machine or equipment builder to analyze the report, there would probably be fewer discharges.

The writer of "Firing Men" does not go far enough; there is a system in vogue at a goodly number of factories, also railroad shops, of hiring new men from the office. Foremen have often been called the key men of industry, and they are proverbially a good-natured bunch and are broad shouldered enough to take it going and coming. But it is always a puzzle to me how any office man or official can know just what kind of a man is best fitted for the particular work required. Who is the first to receive criticism when production slackens? Who knows first which man is unfitted for the job he is on?

Different jobs require different standards of physique and mental qualifications and it is usually up to the foreman to get 100 per cent production without a balanced staff, owing to a faulty system of hiring. I have seen 250-lb. men hired to run a small shop gasoline truck and 120-lb. men for blacksmiths' helpers.

Is it any wonder that the foreman occasionally gets out of hand and fires one of these misfits?

While I entirely agree with the writer of "Firing Men" in his system of personally interviewing every man fired, let him go one step further and allow his foreman to pass on every man hired, and I am convinced that his percentage of discharged employees would be still lower.

Foreman.

What a Car Foreman Is

To the Editor:

Here is an answer to the question, "What Is a Car Foreman?," which appeared among the Gleanings on page 313 of your July issue. (No doubt the writer of the paragraph is a car knocker, and perhaps it is not only cars that he knocks.)

Years ago, as I sat on a station platform, with a long freight train passing, I could hear one car approaching. It sounded as if there was a squealing hot box somewhere. Knowing that the train was made up only a few miles away, a hot box did not seem possible. As the car approached I managed to look under it and noticed that the flanges of the rear truck appeared to be trying to mount to the top of the rail. I raced ahead two or three cars and climbed up between them; by waving and shouting I attracted the attention of several other employees. They got the attention of the tower and the train was stopped.

A fast passenger train was due and after it had passed, the freight car was inspected. Nobody could see anything wrong with it, except one man, and he ordered the car out. As it was passing over a cross-over it toppled over onto the very rail that the passenger train had passed over only a few minutes before, blocking the tracks. All I want to say is, that the man who knew enough to cut the car out was a car foreman.

Observer.

What Is a Car Foreman?

To the Editor:

Referring to the item on the Gleanings page of your July issue, entitled, "What Is a Car Foreman?"

I became a car foreman in 1914, so that my experience in this department covers a period of 22 years. It is too bad that some of our shop foremen are not given an opportunity to come into more intimate contact with the outside car foremen. It would greatly enlighten them as to the duties, responsibilities and other trials which are an everyday occurrence in the life of the car foreman.

What are the car foreman's duties? He should have a thorough knowledge of car work. He should be able to handle mechanics and, if necessary, instruct them in the work which they are called upon to perform. He should be able to train young men to be good mechanics, imparting to them knowledge he has gained from actual work and experience. He must keep well posted on supervision, as well as on the short cuts in his work.

When a car or coach leaves the shop and is placed in service it becomes the responsibility of the car foreman and remains his responsibility until it ends up in the dismantling grave yard. Railroads may provide fine roadbeds, splendid motive power, high-class and expensive equipment, but it is the contents of the freight cars and the passengers in the coaches and other passenger equipment which bring in the revenues. The car foreman must keep the cars moving, whether it be a crack express train or the high-powered manifest. He and his helpers must be on the job, whether the weather be 40 below zero or 110 in the shade, rain or shine.

Mr. Backshop Foreman can sit in his comfortable home and enjoy everything that the railroad brings to his door. When he takes a trip over the railroad and rests comfortably in a Pullman sleeper, he will if he listens, hear the box covers being opened and closed, the tapping of the hammer on the wheels and the testing of the air brakes. The car foreman and his men are out there on the job, night and day, seeing that everything is O.K. and that the train gets to its destination safely.

The signing of the time cards by the car foreman is a very small item in his daily routine, but it gives him little time for relaxation, and "Goodness only knows" that is something he needs, especially when he has acted as a buffer or punching bag for the various officials, from the general superintendent down. His shoulders must be broad and strong to carry the many complaints that come from the A.A.R. inspectors, the head office time keeper, I.C.C. inspectors, the safety engineer, etc., and hard as he tries he cannot seem to satisfy them all.

Car Foreman.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Car Shortage Threatened

Your basic thought in the page of your August issue, entitled, The Editor's Desk, is absolutely sound. It is my feeling that if it had not been for the drought there would have been an actual car shortage this fall. The railroads are certainly working very close to the line in connection with available car equipment.

New Machine Tools Needed

In the article on the Reading Locomotive Shop in your June issue, page 233, Table 1 shows the average age of machines retired to have been 34.8 years. The facts speak for themselves and bring us again to the point of looking up to the automobile industry which has always been ready to consider new machine tool equipment which can produce even a fraction of a second faster than they are now doing.

Railroad Worker Lucky

The railroad worker knows that our business has suffered severely throughout the depression, but any thoughtful, fairminded man is bound to admit that this great business is continuing to pay a relatively higher standard of wages than is being paid in industries in general for the same class of work. Make inquiries around town about wages and working hours in any of the industrial plants and the comparison will be calculated to make you think yourself lucky.

The Grouch

Recently I had a nice visit with the shop superintendent of a large industrial plant. We got to talking about the great changes in the relationships between management and men which are taking place in the more successful plants. This is what he told me:

"I had a little run-in with Friend Wife a while ago in trying to tell her how she could improve upon her kitchen management. She got plenty sore and told me she had heard that I spent my time in the factory finding fault and looking for nothing but defects, shortcomings and other irregularities—that I was oblivious to things that might be well worth commending. She went on to say that in consequence of living in such a faultfinding atmosphere I was becoming a grouch at home, too. She suggested that I should get wise to myself or I would not have a friend left in the whole works.

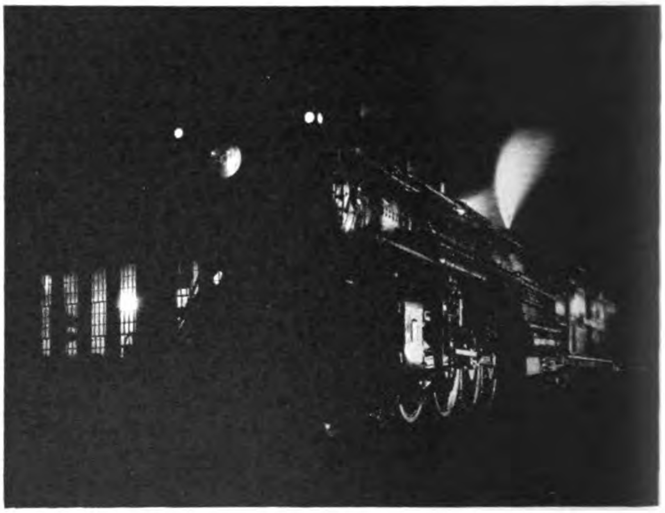
"Now the 'heck' of this was that to some extent she was quite right about seeing only the faults, because that is all I had been looking for, or was particularly interested in.

"Well, I decided I would try looking for praiseworthy things and soon found something well worth special notice. I called the foreman of the department—he was not looking any too happy—and told him how pleased I was to note so and so. The poor fellow became so embarrassed that it affected me somewhat as well. To tell the truth, he almost fainted. So I passed on down through the shop. Stopping at a lathe I told the machinist that he was taking a nice cut and commented on how well his tool was ground to peel off the metal in such a way. Then I went on to tell him how years ago I had run a big lathe. The reply was, 'Gosh, Mr. ———, when you started over towards me I nearly dropped dead and wondered what I was doing wrong; I almost expected to get canned.'

"That was when I really did get wise to myself, and will you believe it, there is now a great difference both in the plant and in myself, and I feel like another man. There is also beginning to be noticeable a slight increase in our output. True, it is only about one and a half per cent thus far, but it is there and may become greater, but it took a scrap with my wife to produce it."

A Unique Photograph

I am enclosing a photograph taken at night of one of our class A engines, No. 2600. It is different from the usual type, the front end being merely suggested by the headlight, which is



dimmed, and the running lights. This engine was ready at the time, to pull No. 3, one of our coach trains.—*George W. McElhinny, machinist apprentice, Northern Pacific, St. Paul, Minn.*

Who Was at Fault?

With the improvement in business and readjustments which we have had to make in our shop supervision, it has been necessary to promote some of the younger men. Perhaps it is the management's fault, which means in this case the shop superintendent, that the following incident occurred.

A young machinist was appointed to a minor supervisory position. Two weeks later the general foreman met him in the shop and commented on the fact that he had frequently noticed a certain one of his men in various places about the shop and apparently for no particular reason. He asked the young supervisor to look into it. That evening, after quitting time, the worker came to the general foreman and said:

"I understand you think I spend considerable time loafing about the shop."

"What makes you think so?" asked the G. F.

"My foreman told me so. He said that you had been after him about it and that I had better keep my eyes open or something might happen. I wish you had told me yourself when you saw me where you thought I ought not to have been. I am always able to give a good account of myself and I think I could have satisfied you that I was not loafing."

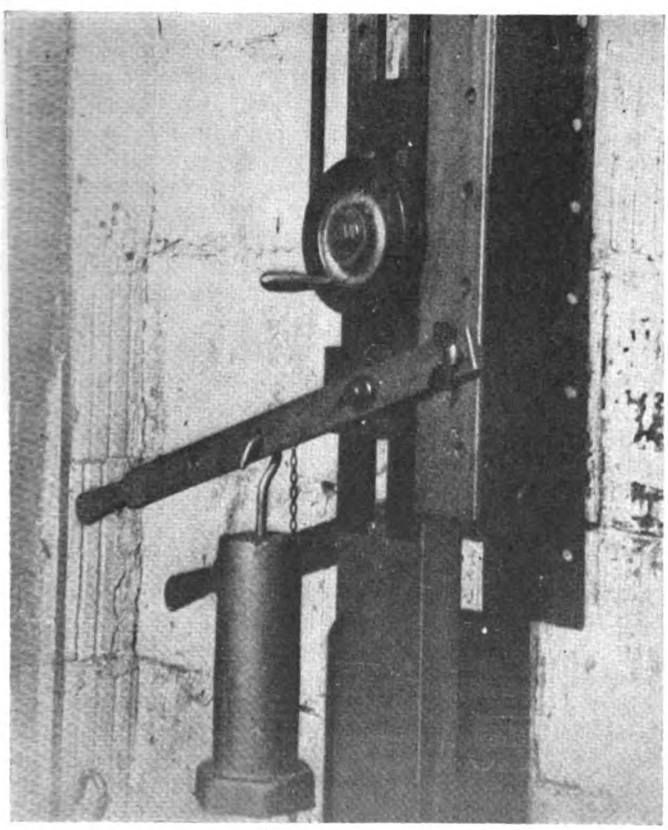
Just who was to blame for this sort of thing happening?

With the Car Foremen and Inspectors

Checking V-Belt Length

A machine for checking the length and testing the strength of endless V-belts is shown in the illustration. Where two or more V-belts are used together, they must be of the same length and have an equal tension or one belt will carry all the load and wear out unduly fast. When one belt of a set breaks, a new set of belts is applied and the serviceable old belts allowed to accumulate until a supply is collected. They are then matched in sets for length and stretched by use of the device shown. Excessive wear on the belt is determined by looking in a hole bored in the bottom pulley and noting how close the belt is to the bottom of V-groove. Belts that come to less than $\frac{1}{16}$ in. of bottoming in the groove should be discarded.

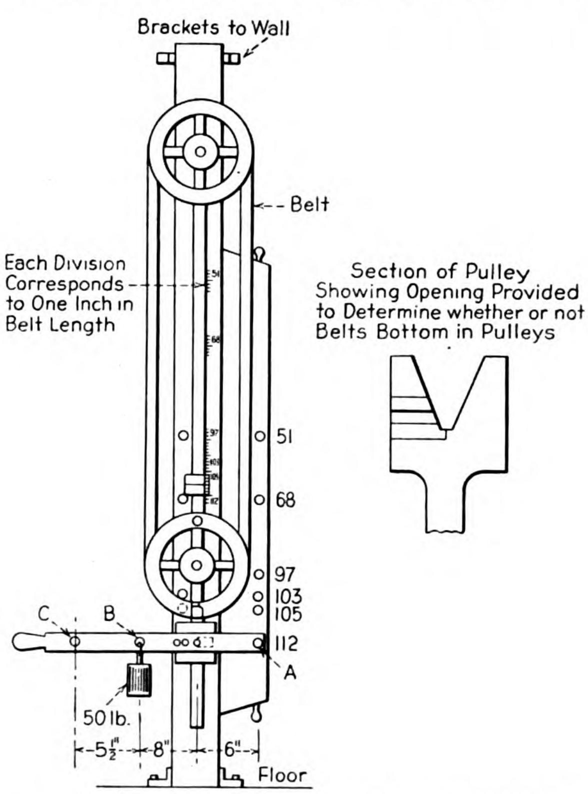
Belts tested with this device include the $\frac{1}{2}$-in., $\frac{21}{32}$-in. and $\frac{3}{4}$-in. endless V-belts of axle-driven generators for car-lighting or air-conditioning equipment. The testing device is secured by brackets to any convenient wall in the car shop or inspection shed. The endless V-belt is applied over two pulleys, as shown, the belt length being indicated by graduations on the sliding scale. A horizontal hand-lever pivoted at *A* exerts a downward pull on the belt by means of a weight suspended at points *B* or *C*. The particular pivot-pin hole selected will depend upon the length of the belt being tested which, in the instance illustrated, is a 112-in. belt. A 50-lb. weight is suspended from hole *B* for testing $\frac{21}{32}$-in. section belts and at hole *C* for testing $\frac{3}{4}$-in. section belts. A 25-lb. weight is used in hole *B* while testing $\frac{1}{2}$-in. section belts.



Weight for stretching the belt under tension while measuring

In order to adjust the machine to measure the length of a belt, the weight is removed from the lever, the lever moved to the horizontal position and held in this position, with the lever-locking pin inserted through the holes in the lever and the $\frac{3}{4}$-in. brass block behind the lever. The pivot pin can then be removed from the right-hand hole in the lever, and the sliding mechanism, of which the lower pulley is a part, can be moved to the proper position in the slot when the lever pivot pin can be inserted. The lever-locking pin can then be removed and the lever raised up until the lever-locking pin can be inserted in one of the large holes in the lever and brass block, and a small hole in the channel iron.

The next step is to apply the proper size weight in the proper hole in this lever; then place the belt to be measured in the pulleys. Relieve the weight on the lever-locking pin by slightly raising the lever, remove the lever-locking pin and gradually allow the lever and weight to lower until the full weight is on the belt. Then rotate the lower pulley by the handle about six times and note the length. Also, it must be noted whether or not the belt sets too low in the pulley grooves. This can be determined by observation through the slot cut in the bottom pulley when the slot is in the down position and the handle up. If it is a serviceable belt, a small white



Arrangement of pulleys and weighted lever for testing V-belt lengths

tag can be attached showing its correct length, and permitting it to be later matched according to the length marked.

In removing a belt from the machine, the lever should be raised and the lever-locking pin inserted in the three holes in the lever, brass block and channel iron, with the lever above the horizontal position.

Each graduation on either side of zero on the sliding scale represents ⅛ in. belt length and each division on the fixed scale represents 1 in. length. No attempt to adjust the sliding mechanism should be made with the weight attached to the lever arm, or belts allowed to remain in the machine under tension over night or at any other time than when it is actually desired to measure them. The weights should also be removed when the machine is not in use.

Manufacturers furnish new belts in matched length sets, and if desired, a check can be made of this feature by measuring new belts in stock at the particular yards where these devices are located.

Questions and Answers On the AB Brake

30—*Q.—What is the duty of the service graduating valve?* A.—Opens and closes passage between: (1) auxiliary and emergency reservoirs with the slide valve in release position. (2) brake pipe and quick service volume with the slide valve in full release position. (3) auxiliary reservoir and brake cylinder with the slide valve in service position.

31—*Q.—What is the duty of the release insuring valve?* A.—To insure return of the service piston to release position in case of excessive slide-valve friction, by exhausting auxiliary-reservoir pressure to the atmosphere.

32—*Q.—What is the duty of the limiting valve?* A.—To terminate secondary quick service when a predetermined brake-cylinder pressure is developed.

33—*Q.—What is the duty of the back-flow check valve?* A.—To prevent flow of brake-cylinder pressure into the brake pipe, such as during emergency, when that pressure is higher than the brake pipe.

34—*Q.—What is the duty of the duplex release valve?* A.—To reduce (manually) auxiliary-reservoir pressure alone, or emergency-reservoir and auxiliary-reservoir pressures at the same time.

35—*Q.—What is the duty of the release and application by-pass check valve?* A.—To by-pass brake-pipe air around the strainer in case of strainer restriction.

36—*Q.—What is the duty of the service-piston return spring?* A.—To prevent movement of the service piston to retarded recharge position, unless brake-pipe pressure is about three pounds higher than auxiliary-reservoir pressure.

37—*Q.—What is the duty of the stabilizing spring?* A.—To provide stability of quick-service activity by preventing movement of the service piston to preliminary-quick-service position until a predetermined difference in pressure is attained between the brake pipe and auxiliary reservoir.

38—*Q.—Name and locate the choke fittings in the service portion.* A.—Preliminary-quick-service choke, located in the body under the release-insuring cover. Quick-service choke, under the limiting-valve cover, and release-insuring choke, in the release-insuring cover.

39—*Q.—What is the size of the opening in the preliminary quick-service choke, and what does it control?* A.—$\frac{1}{32}$-in. opening. Restricts the flow of air from the quick-service volume to the atmosphere and provides the secondary quick-service function.

40—*Q.—What opening has the quick-service choke, and what does it control?* A.—$\frac{1}{32}$-in. opening. Restricts the flow of air in the quick-service passage between the slide and limiting valves.

41—*Q.—What is the size of the opening in the release-insuring choke, and what does it control?* A.—$\frac{1}{32}$-in. opening. Controls the flow of air in the passage between the release-insuring valve and slide-valve exhaust in service-lap position.

42—*Q.—What volume is incorporated in the service portion, and what is its purpose?* A.—The quick-service volume, into which the brake-pipe pressure flows, to initiate preliminary quick-service.

43—*Q.—To what is the volume at all times connected?* A.—To the atmosphere, through the preliminary quick-service choke plug.

44.—*Q.—How many springs are contained in the service portion?* A.—Twelve springs.

45—*Q.—Name them.* A.—(1) Graduating-valve spring. (2) Slide-valve spring. (3) Piston spring. (4) Return spring. (5-6) By-pass check-valve springs (2). (7) Diaphragm spring. (8) Limiting and back-flow check-valve spring. (9) Duplex release-valve plunger spring. (10-11) Release check-valve springs (2). (12) Release-insuring-valve spring.

46—*Q.—It being understood that the valve springs are for the purpose of holding the various valves to their seats, what are the duties of the other springs mentioned?* A.—Piston spring resists the movement of piston and graduating valve after the feed grooves are closed, and just previous to opening of the preliminary quick-service port. Return spring returns piston and slide valve from retarded re-charge to normal re-charge position. Diaphragm spring acts on the diaphragm of the quick-service limiting valve to hold it open until the force of the spring is balanced by a cylinder pressure of 10 lb. Release-insuring valve spring holds this valve on its seat until brake pipe pressure rises 1½ lb. above auxiliary reservoir pressure.

Emergency Portion

47—*Q.—Name the operative parts of the emergency portion.* A.—(1) Emergency piston. (2) Emergency slide valve. (3) Emergency graduating valve. (4) Vent valve and piston. (5) Accelerated-release piston. (6) Spill-over check. (7) Ball check. (8) Accelerated-release check valve and ball check. (9) Inshot piston. (10) Inshot valve. (11) Timing valve.

48—*Q.—What is the duty of the emergency piston?* A.—Acts as a dividing line between brake pipe and quick-action chamber and operates the emergency slide and graduating valves.

49—*Q.—What is the duty of the emergency slide valve?* A.—Controls the flow of air from: (a) Quick-action chamber via graduating valve to atmosphere during service applications. (b) Quick-action chamber to vent-valve piston in emergency. (c) Quick-action chamber to outer face of accelerated-release piston, except in emergency. (d) Emergency reservoir to outer face of accelerated-release piston during emergency. (e) Emergency reservoir to brake cylinder in emergency. (f) Brake cylinder to brake pipe (via checks 93 and 94 during release after emergency). (g) Brake cylinder to outer face of inshot piston (through inshot volume), except during emergency.

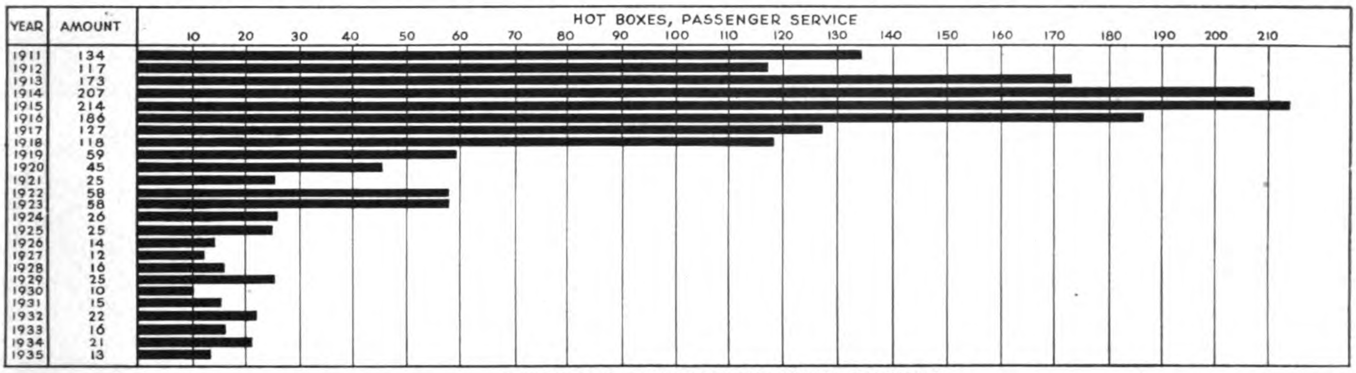
50—*Q.—What is the duty of the emergency graduating valve?* A.—Controls the flow of air from: (a) Quick-action chamber to atmosphere during service applications. (b) Quick-action chamber to vent-valve piston during emergency applications.

What Has Happened To the Hot Box

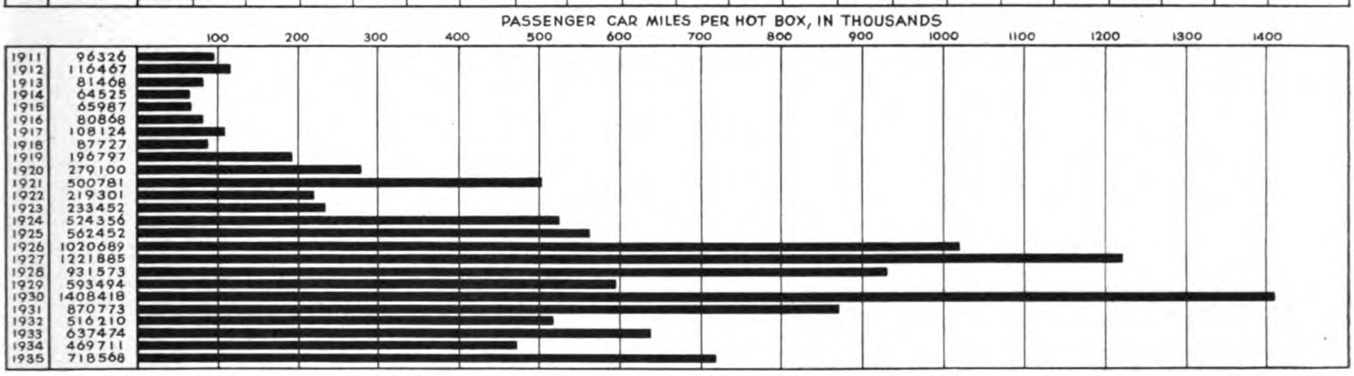
The accompanying charts, reproduced from the May 1, 1936, issue of the Delaware & Hudson Bulletin, tell their own story of the improvement which has taken place during the last quarter century in one important phase of railway operation on this railroad. The marked improvement which has taken place since 1927 is attributed to three remedial measures: The use of materials (oil and waste) of proper quality; the adoption of a satisfactory system of caring for journal boxes and contained parts, and the correction of improper truck details, such as springs.

A.A.R. Rule 66, adopted March 1, 1929, has been a factor in reducing hot-box trouble on all railroads. A system of education in effect on the D. & H. insures that all supervisors and subordinates who have anything to do with journal-box and wheel maintenance are properly instructed. Periodic checks determine whether such matters are being given uniformly correct handling at all points.

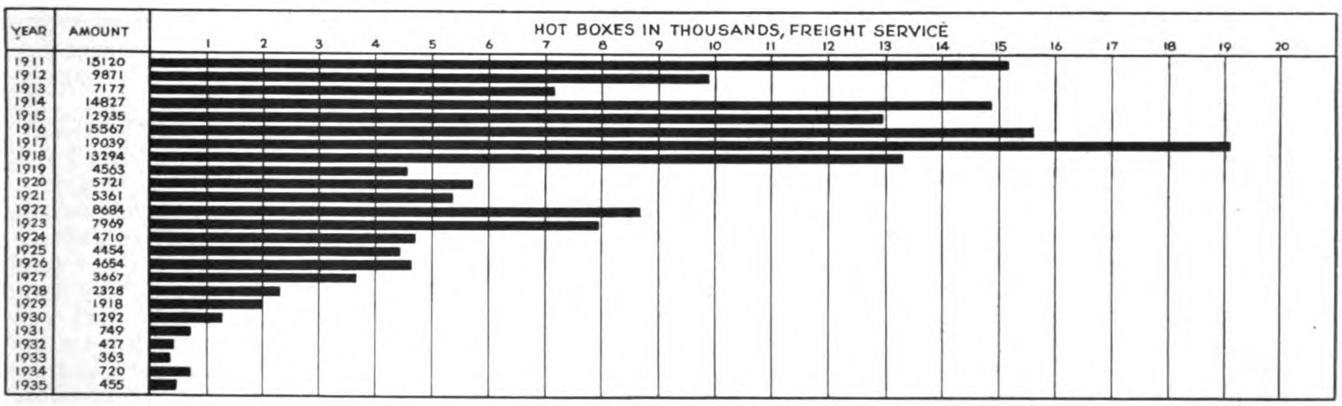
During the period reported no change has taken place in the definition of a hot box, although the count of train delays on account of hot boxes is said to be more strict in recent years than during the earlier part of the period covered by the record. While the record covers the D. & H. only, it may be considered as typical of the results obtained where close and systematic attention



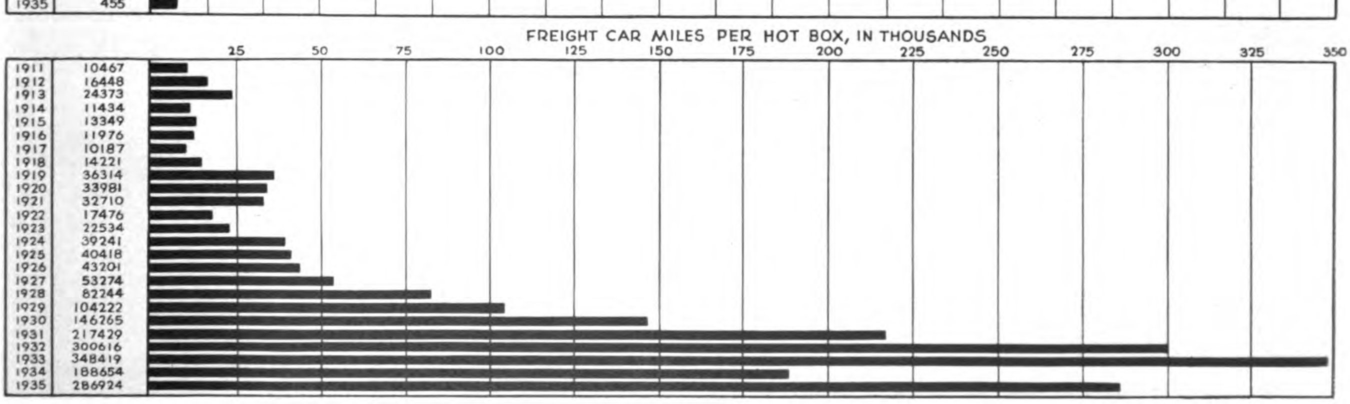
YEAR	AMOUNT
1911	134
1912	117
1913	173
1914	207
1915	214
1916	186
1917	127
1918	118
1919	59
1920	45
1921	25
1922	58
1923	58
1924	26
1925	25
1926	14
1927	12
1928	16
1929	25
1930	10
1931	15
1932	22
1933	16
1934	21
1935	13



YEAR	AMOUNT
1911	96326
1912	116467
1913	81468
1914	64525
1915	65987
1916	80868
1917	108124
1918	87727
1919	196797
1920	279100
1921	500781
1922	219301
1923	233452
1924	524356
1925	562452
1926	1020689
1927	1221885
1928	931573
1929	593494
1930	1408418
1931	870773
1932	516210
1933	637474
1934	469711
1935	718568



YEAR	AMOUNT
1911	15120
1912	9871
1913	7177
1914	14827
1915	12935
1916	15567
1917	19039
1918	13294
1919	4563
1920	5721
1921	5361
1922	8684
1923	7969
1924	4710
1925	4454
1926	4654
1927	3667
1928	2328
1929	1918
1930	1292
1931	749
1932	427
1933	363
1934	720
1935	455



YEAR	AMOUNT
1911	10467
1912	16448
1913	24373
1914	11434
1915	13349
1916	11976
1917	10187
1918	14221
1919	36314
1920	33981
1921	32710
1922	17476
1923	22534
1924	39241
1925	40418
1926	43201
1927	53274
1928	82244
1929	104222
1930	146265
1931	217429
1932	300616
1933	348419
1934	188654
1935	286924

has been given to the three important items listed above —the use of proper materials; careful and systematic attention to journal boxes, and the correction of truck details affecting journal-box performance.

Reaming Device for Brake Beam Heads

*By A. Skinner**

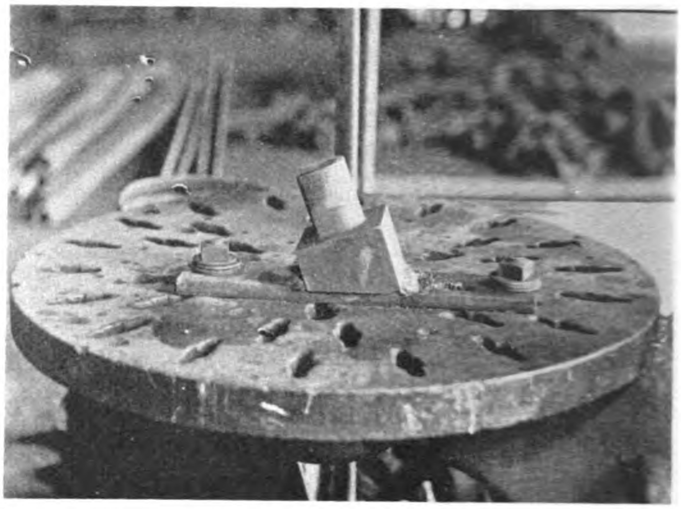
To conform to a recent ruling that all tension rods for brake beams be changed from 1¼ in. to 1⅜ in. when brake beams are sent in for repairs, it is found necessary to ream or drill out the heads to accommodate the larger rods. Since the tension rod hole must be at an angle of 25 deg. with the channel bearing surface, it assists greatly in the drilling operation if the jig can be used to hold the brake head at such an angle on the drill table that the hole will be vertical.

A jig, designed for this purpose, is shown both separately and with the brake head applied, in the illustrations. It consists of a steel base plate ⅝ in. thick, by 4 in. wide, by 16 in. long, to which is welded a steel block chamfered on the bottom to an angle of 25 deg., and having a U-shape steel back piece welded to the top in such a way that the brake head can be fitted over it with no clamps necessary to hold the head during the drilling or reaming operation. This U-back was cut from an old back taken from a scrap brake beam.

The jig is secured to the drill table by means of two bolts and when the brake head is applied the truss-rod hole is vertical and can be drilled or reamed with the assurance that the hole will have the proper angle. The use of this jig assures a uniformly accurate drilling operation, and owing to the ease of setup and the elimination of time required for applying and removing clamps, the production is greatly increased.

* General foreman, Atchison, Topeka & Santa Fe reclamation plant, Corwith (Chicago), Ill.

A brake head on the jig ready for the drilling operation

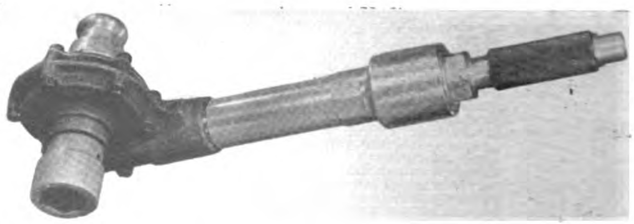


The brake head drilling jig set up on the drill table

Hamerench for Applying And Removing Nuts

A pneumatic tool which combines the actions of a hammer and a wrench in a distinctly new principle of operation is now being introduced by the Independent Pneumatic Tool Company, Chicago. This new tool, known as the Thor No. 603 Hamerench, is designed to apply and remove all types of nuts, staybolt caps, etc. in locomotive repair work and also be adaptable to the extensive nut running and removing operations in railroad car shops, enginehouses, etc.

Made of alloy steel throughout, and with parts proportioned so as to avoid overstress and consequent possibility of failure at any point, the Hamerench construction is notable for simplicity and ruggedness. The ratchet collar, shown in detail in one of the illustrations, receives its motion from a piston in the hardened steel pneumatic hammer barrel, and it, in turn, actuates a spindle which drives the socket. Nuts and flexible caps are applied and removed by perfectly timed impacts, 1,800 to the minute, with no backup of the ratchet collar possible owing to the pawl action. All torsion developed by each impact is absorbed in the tool, providing maximum safety to the operator. In fact, the tool can easily be worked with one hand, the speed and power of the blows being controlled by the operation of a self-closing hand throttle. Changing the socket



General view of the Thor Hamerench used in applying and removing nuts

from one end of the spindle to the other makes the tool reversible. The right-angle type construction of the tool permits operating it in places inaccessible to other types of machines designed for a similar purpose. The tool can be used with very little strain or fatigue, regardless of the position of the nut which is being applied or removed.

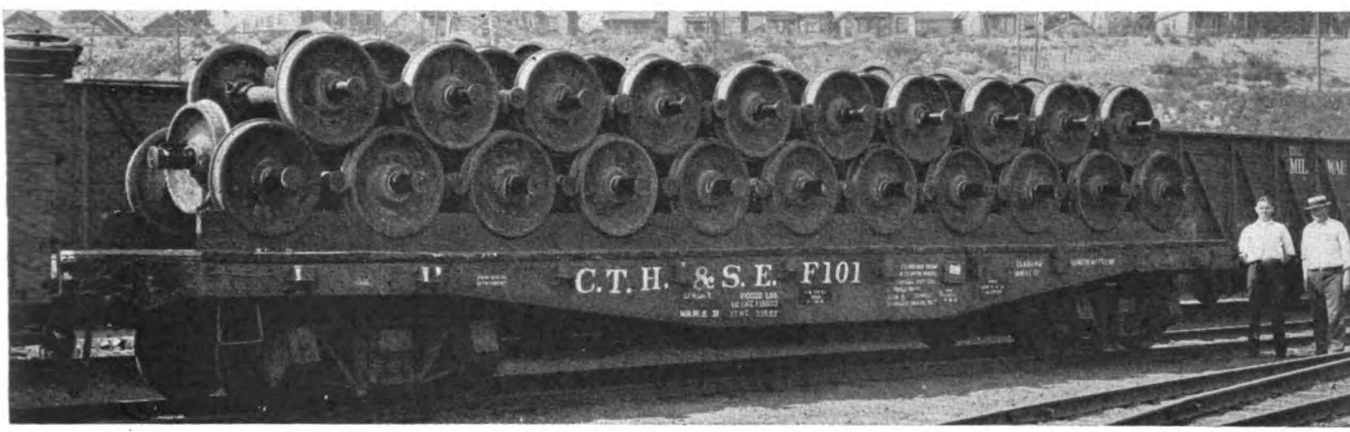
In designing the ratchet collar of the Hamerench, the distribution of the impact is controlled by a unique arrangement of the teeth. All parts of the Hamerench which have threaded connections utilize a new form of construction providing 50 per cent increased strength. The wrench is so designed that all moving parts are readily accessible for inspection or replacement, if necessary. There are no gears in this new tool. Lack of vibration in operation protects the square socket hole which does not become rounded and thus lessen its effectiveness as well as having a tendency to cause rounded nut corners.

The Thor No. 603 Hamerench is designed for use with all sizes of nuts up to 1⅛ in., although under ordinary conditions even larger sizes can be accommodated. The sensitive response of the wrench to the hand throttle enables the operator to avoid breakage and stripping of threads on smaller bolts. Extension adapters are available for use in awkward places which could not otherwise be reached.

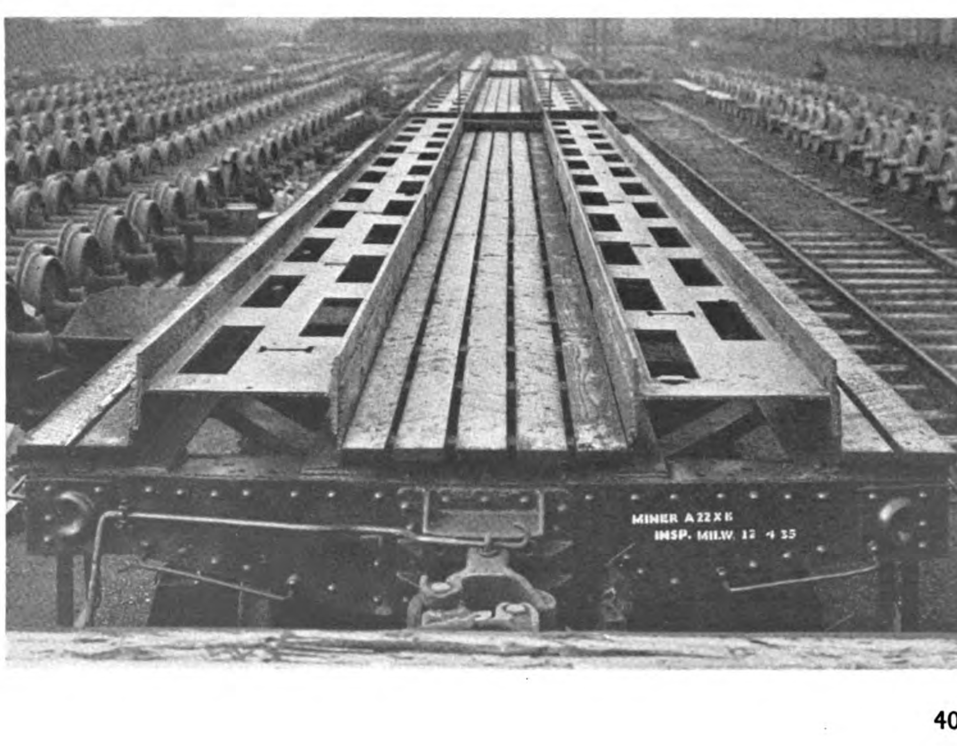
Milwaukee Double-Deck Wheel Cars

For several years, the Chicago, Milwaukee, St. Paul & Pacific has been handling car wheels to and from the main car wheel shop at Milwaukee, Wis., on special double deck wheel cars which were first described in the *Railway Mechanical Engineer* of February, 1932. One of these cars, equipped with 20-in. I-beams, having alternate staggered openings to accommodate the mounted car wheels, is illustrated. Another car, equipped with an earlier type of double deck loading arrangement, is shown in the second illustration.

The extensive use of these type of cars, adapted to double deck loading, is predicated upon the fact that only one-third of the number of cars needed for handling wheels is required, as would be the case with single deck loading. In the case of the Milwaukee, which formerly used about 7,700 cars per year for handling mounted wheels, this means a reduction to 2,570 cars. Moreover, an additional saving of $2.81 per load is effected due to the fact that the wheels do not have to be blocked. There is also a large saving in decking which is usually badly damaged or worn out after one or two trips with a double-deck load of car wheels on conventional flat cars or gondolas.



One of the earlier types of double-deck car-wheel-loading devices used on the Milwaukee



Flat car arranged for double-deck wheel loading at Milwaukee shops

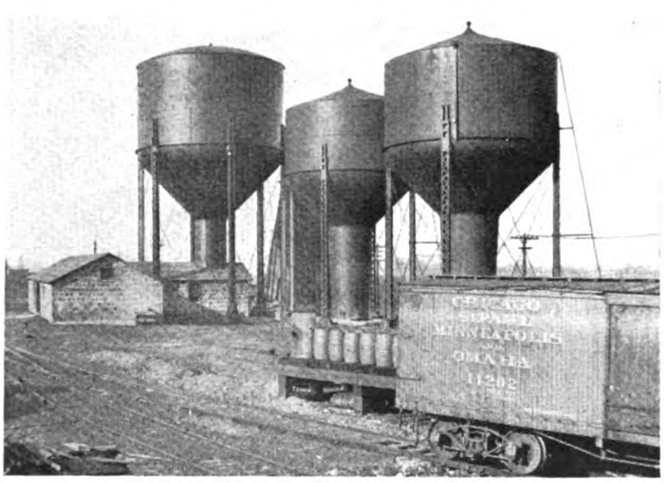
IN THE BACK SHOP AND ENGINEHOUSE

Treating Railway Water

*By R. E. Coughlan**

Practically all of the railroads operating steam boilers have, from time to time, experienced trouble due to leaking boilers, waste of fuel and various operating delays on account of unsuitable water. This is due to the fact that natural water obtained from wells, streams, lakes, etc., is never chemically pure. A chemically pure water is only obtained by the condensation of steam in a closed vessel.

The common source of supply of water originates with rainfall, at which time the water passing through the air absorbs the gas known as carbonic acid. After reaching the earth, the water, as it seeps away into the ground, dissolves various mineral salts from the soil. It is these mineral salts dissolved which give to the water what is commonly known as the hardness. These mineral salts usually found dissolved in practically all natural waters are the various salts of lime and magnesia. The most common of these which the railroads encounter in water supplies are principally the following: Calcium carbonate (chalk), magnesium carbonate (talc), calcium sulphate (gypsum) and magnesium sulphate (epsom salts). In

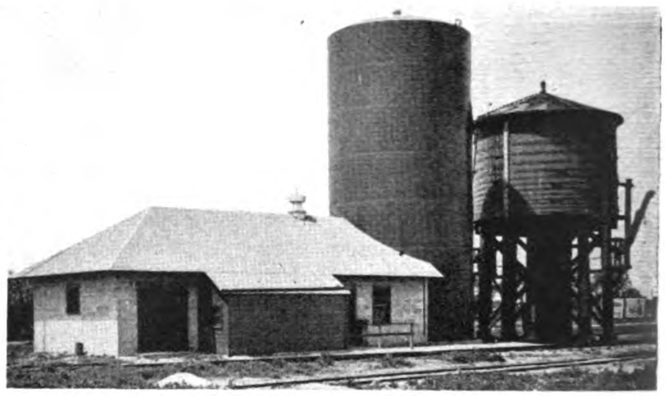


Exterior of 35,000-gal. per hr., continuous type, lime, soda ash and sodium aluminate water softening plant at Butler, Wis.

addition to these four, most waters contain some silica and small amounts of the salts of iron.

It is the duty of the railroad water service engineer to obtain, if possible, the best water available on the various districts of the railroad, which water will contain the least amount of the mineral salts responsible for hardness. As this on most railroads is a physical impossibility, the most economical method of supplying a suitable water for locomotive use is by softening the available water.

The chalk and talc are often referred to as temporary hardness, because of the fact that heat alone will remove the greater percentage of these mineral salts. Heat drives off the carbonic acid gas which in turn is responsible for keeping the chalk and talc dissolved in the water. The gypsum and epsom salts can only be removed by complete evaporation or by chemical treatment. The most common chemical used for this purpose is carbonate of soda, known as soda ash. This chemical changes the sulphate of lime and magnesia to sulphate of soda, commonly known as glauber salts, which material will remain dissolved in the water and will not



Complete lime, soda ash and sodium aluminate water treating plant, capacity of 12,500 gal. per hr., continuous type, at Scribner, Nebr.

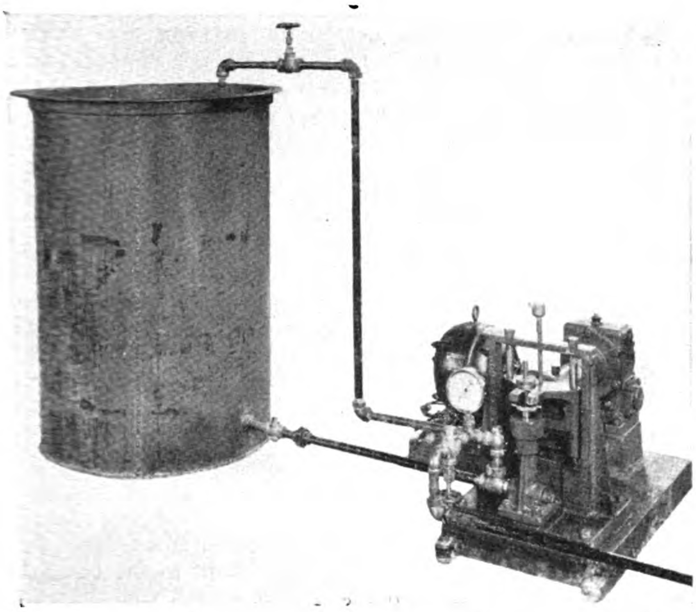
cause any hardness. Insoluble chalk and talc, which settle out of the water, are also formed by this treatment. The chalk and talc found normally in water are usually removed by the addition of a strong solution of lime water (calcium hydrate) or caustic soda which absorbs the carbonic acid gas, after which the chalk and talc settle out of the water on standing.

In a modern water softening plant, the soda ash and lime water are added simultaneously in direct proportion to the amount of mineral salts dissolved in the water, as shown by a chemical analysis of the natural water which is to be softened. The softened water, or, as it is commonly known in railroad service, treated water, contains in solution the glauber salts and a small percentage of the original chalk and talc, plus a slight amount of lime water and soda ash.

When water is softened and its original content of mineral salts removed or changed, its behavior when used

Interior view of water, softening plant at Butler, Wis.

* Supervisor of Water Supply, Chicago & North Western, Chicago.

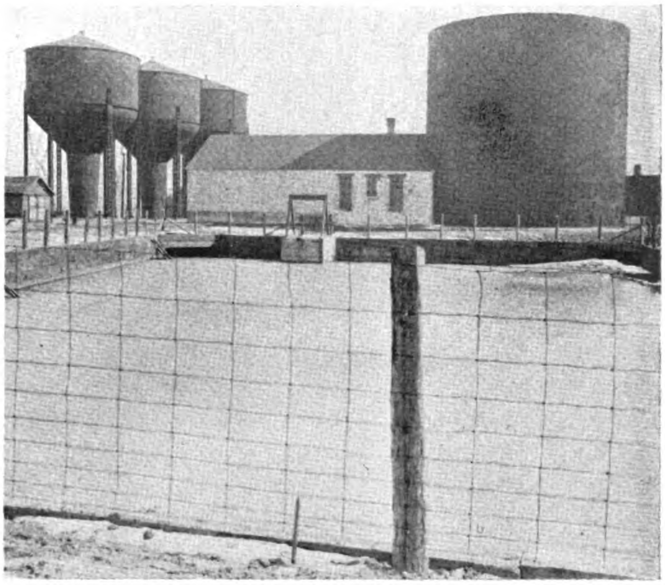


Type of equipment installed in a wayside sodium-aluminate treating plant

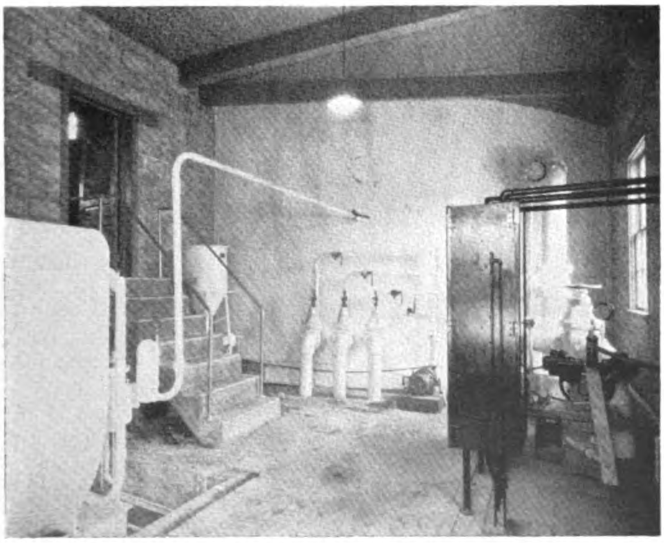
for the generation of steam also changes. When large amounts of chemicals must be used, the treated water is sometimes referred to as light. This means that the softened water, having in solution large amounts of sulphate of soda (glauber salts) in addition to a slight excess of the chemicals used in the treatment, has a tendency to build up bubbles on the surface of the water in a boiler, which, in turn, retards the free and rapid escape of the steam so that sometimes water is carried out of the boiler in small drops with the steam. This is known as foaming. This is aggravated by the presence of suspended matter in the water. This trouble is somewhat different from that which is known as priming, although both foaming and priming are often referred to as the same trouble. Priming consists of water suddenly leaving the boiler with the steam in comparatively large amounts, due to the nature of the chemical salts in solution, suspended matter, operating the boiler beyond capacity, sudden opening of the throttle, restricted steam space, or a combination of two or more of these causes.

The amount of the mineral salts changed over to the soluble form in a softening plant accumulates in the boiler upon continual evaporation of additional water. The amount of such salts sometimes increases to such quantity that foaming occurs, unless these mineral salts are reduced by means of the blow-off cocks. Blowing out the boiler usually reduces such concentrations to a satisfactory operating amount. The increased cost of this blowing out, with its attendant loss of water and steam, is more than offset by the improved operating condition of the boiler and its long life, due to its general cleanliness. When the total concentrations become so high that the blowing out of the boiler cannot keep these concentrations reduced to a satisfactory operating degree, it has been found that anti-foam boiler compound will be of great help in operating with these higher concentrations. The best of these anti-foam compounds contain approximately 15 per cent of vegetable castor oil emulsified with tannin extract or similar material.

It has sometimes been found that with water partially treated or containing large amounts of temporary hardness, unless all of this hardness is removed, trouble is experienced with the brass fittings, boiler checks, feed pipes, cab fittings, etc., due to the accumulation of the temporary hardness which adheres to these fittings. This necessitates frequent cleaning of such fittings, or complete treatment, followed by the use of such material as tannin extract, sodium aluminate or similar material, to eliminate this trouble.



Reservoir, softening tank, and three softened water storage tanks at Proviso, Ill. Capacity of plant 100,000 gal. per hr., continuous type, lime, soda ash and sodium aluminate treatment



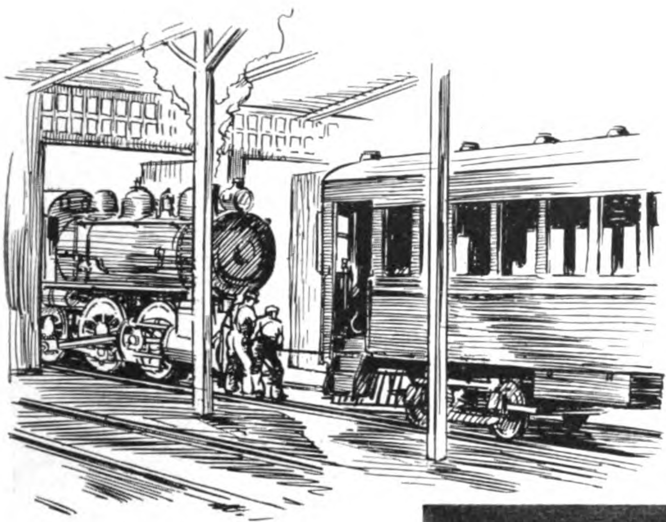
Interior of 100,000 gal.-per-hr. complete lime, soda ash and sodium aluminate water softening plant at Clinton, Iowa. In this plant, all facilities are started and stopped by means of automatic electric control

In addition to the operation of lime and soda ash complete water softening plants, many of the railroads today have found it to be a decidedly profitable investment to use wayside methods of water treatment, and, also, various boiler compounds.

In the wayside method of treatment, no additional settling tanks or treating tanks are necessary. Such chemicals as sodium aluminate, caustic soda, tannin extract, soda ash and the various forms of sodium phosphate are fed directly into the wayside storage tank by means of small automatic feeding devices which proportion to the water the exact amount of treatment required to neutralize the scale foaming salts in the water. The chemical reactions in this method of treatment are completed in the locomotive boiler; and by means of intelligent methods in keeping the boiler concentrations re-

(Continued on page 413)

MOTOR CARS Are So Costly



"BUT we don't want any motor cars on the Plains Division—they're always giving trouble. We used to have one running out of Sanford. When it wasn't tied up for repairs it was being pulled in with a locomotive," H. H. Carter, master mechanic of the Plains Division of the S. P. & W. argued.

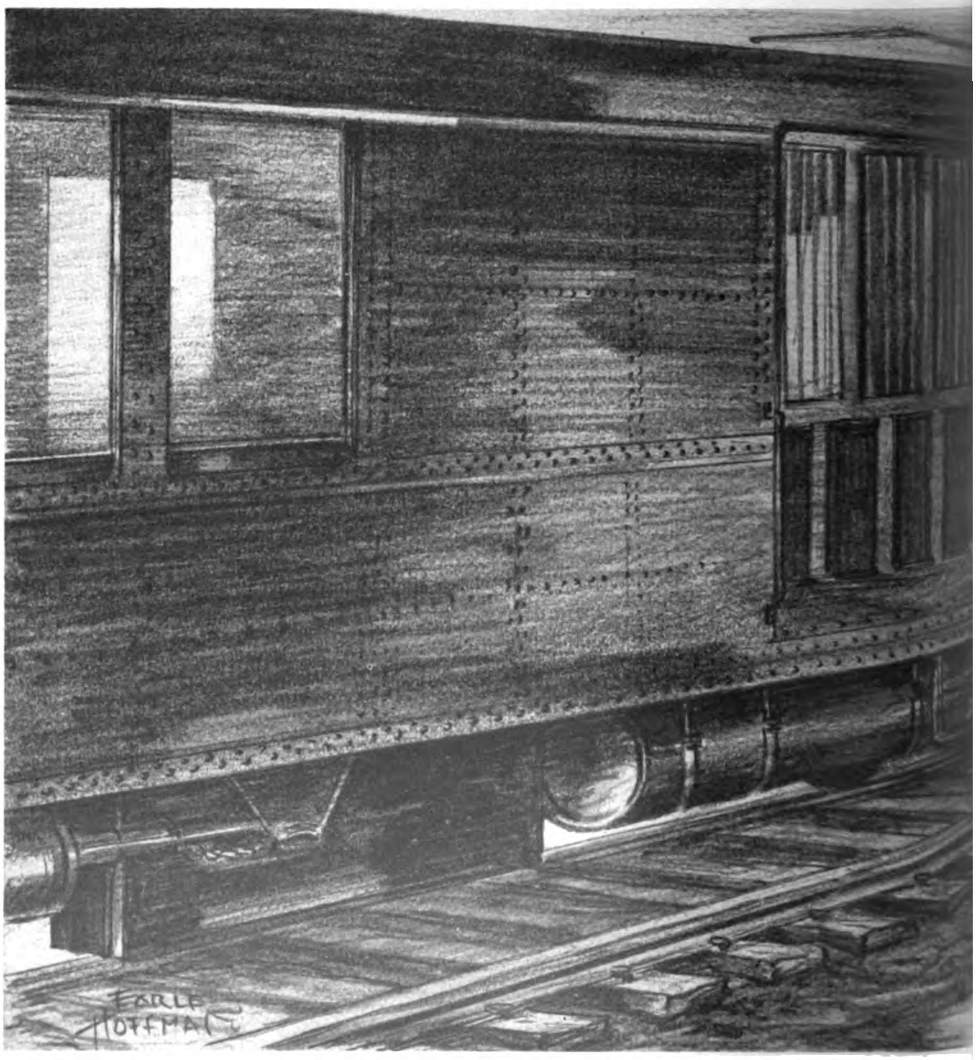
"That's true, you did have a lot of trouble," the superintendent of motive power agreed, "but they're being run successfully on other divisions and there's no reason why it can't be done on the Plains Division. At any rate, you're getting one next week for the local run between Plainville and Sanford, and you might as well make up your mind to like it—and to keep it running!" the S. M. P. added.

"O. K." The master mechanic forced a smile. "But I'm afraid we'll find it more expensive to operate than a steam train. We'll do our best, though," Carter added when he noticed the lines around the S. M. P.'s mouth tighten.

The superintendent of motive power left on No. 10. After the Limited pulled out, Carter went to the roundhouse to break the news to Jim Evans, the roundhouse foreman. Evans liked motor cars about as well as the master mechanic, which was not at all.

Evans was in the roundhouse office trying to figure how to stay within his allowance and still keep the engines running when Carter came in.

"Getting a motor car next week," Carter announced as though it was the best news in the world.



The motor car arrived Sunday afternoon. Ray Anderson, traveling motor-car supervisor, was with it. Evans was waiting by the office

"What!" Evans forgot to close his mouth until tobacco juice running out the corner reminded him that it was open.

"Yeah, we're getting a motor car for the local run between here and Sanford."

Evans spat and bit off a hunk of "horseshoe." "Why, dammit, we had a motor car on that run once and it was always giving trouble! It made the failure sheet look like a football score. Run up M. of E. costs, too!"

"Yeah, I remember, but they're running them successfully on other divisions and there's no reason why we can't do it here. You might as well make up your mind you're going to do it and like it." The master mechanic quoted what he had heard about an hour before.

"Who you got to put on as maintainer? We'll need a good man."

"Well, to tell the truth we don't have any one. Martin is the only man we have that is qualified on motor cars but he won't bid on the job. He's on the lead job in the machine shop. He'd be a good man if he'd take it," Evans added.

"Get him on it if you can. Better get a bulletin posted on the job today," Carter said and left Evans alone with his worries.

There were no bids for the job maintaining the motor car. Evans tried to persuade Martin to bid on it, but the machinist couldn't see it that way. Less grief and more money on the job he had. Baker, the youngest machinist in seniority, was forced on the job.

by
Walt Wyre

● ● ●

"Well, anyway, I'm glad to get Baker off the drop-pit. He does just enough to keep from getting fired and little enough that every engine coming off the drop-pit is delayed," Evans commented when the time had expired on the bulletin with no bids.

THE motor car arrived Sunday afternoon. Ray Anderson, traveling motor car supervisor, was with it. Anderson ran the car to the roundhouse. Evans was waiting by the office.

"What engineer is getting the motor car?" Anderson asked.

"Looks like now it'll be Stewart. He's the only man bidding on it. It's either that or the extra-board," Evans added.

"Don't seem to remember him. Is he qualified on motor cars?"

Evans bit off a hunk of horseshoe. "I don't think so."

Anderson groaned. "Next thing I guess you'll be telling me that I'm getting a green maintainer."

Evans spat reflectively. "You're right, first guess."

Anderson groaned again, louder than before. "I can see where I have a nice vacation—riding the car all day, then working all night. It's a great life! Maybe some

of these days motor car maintainers will be in a separate craft altogether. But guess it's too much to hope for." Anderson shrugged his shoulders and walked over to the office to send a message notifying the superintendent of motive power of his arrival in Plainville.

"What kind of engineer is Stewart?" Anderson asked John Harris, the clerk.

"Oh, he's all right, I guess. He took the examination three times before he was promoted," the clerk replied.

"Damn!" Anderson exploded, "and they complain of motor cars giving trouble! It's a wonder they do as well as they do. Of course we've got good men on them at some points, maintainers and engineers too, and they don't give trouble, either," the supervisor said.

The motor car maintainer came to work at eight o'clock. Anderson stayed with him until midnight and did practically all the work. Baker broke the porcelain of four spark plugs taking them out to clean them.

Anderson was up at six o'clock next morning. He wanted to look the car over before time for it to start out on the run at 7:45. He reached the roundhouse a little before 7 o'clock. The car was still in the stall. The hostler and his helper were fixing to get the car out of the house by pulling it with a cable attached to the switch engine when Anderson got there.

"What's the big idea?" Anderson asked. "Won't it run?"

"Don't know," the hostler replied. "I never run one of them."

Anderson climbed up in the car and started the number two motor, that is, he turned on the ignition and pushed the starting switch. The engine popped and sputtered, kicked over a few times and died. He pressed the starting switch again. There was a loud explosion in the exhaust.

Anderson shut off the ignition and went back to look at the engine. "Well, I'll be damned!" he exclaimed.

"What's the matter? Something wrong?" Evans had climbed up in the car to see why the delay getting out.

"Why, the blasted dumb-bell has got the spark plug wires all crossed up. He must have pulled them out of the distributor, then put them back without paying any attention to firing order or anything else." Anderson was busy straightening out the wires as he spoke.

The car got out thirty minutes late the first day but with the supervisor at the throttle reached Sanford on time.

ANDERSON put in the next six days and most of the nights with the motor car. He got so far behind with his sleep that he could go to sleep standing up like a horse. By the end of the week he was planning to take his vacation, if and when he got one, at the North Pole and sleep from sunset to sunrise.

Saturday morning Anderson received a wire to go to another division to break in a maintainer. Stewart took the car out alone for the first time. A steam locomotive brought the train in that evening. The engineer made a flag stop at Guys, eleven miles out of Sanford. When the conductor gave the highball, Stewart started the car with the controller handle in parallel position and with the brakes set.

There was a muffled thump-thump under the car. Too late Stewart closed the throttle. Two motors had flashed over. Number one motor melted two brush holder leads completely through and the commutator looked like it had been in a fire. Number two motor wasn't so bad, but the commutator needed dressing and one brush holder was damaged beyond repair. After thirty minutes delay, Stewart figured out how to cut out the damaged motors as he had been instructed and the car limped into Sanford.

Anderson got back to Plainville Sunday night. Machinist Martin was called in to help on the car Sunday night, at time-and-a-half. The car was ready to go out on the run next morning at schedule time. Anderson went along after having had three hours sleep and breakfast of two cups of black coffee and an aspirin.

Thursday, Anderson received a wire from the superintendent of motive power wanting to know if the motor car supervisor had located permanently in Plainville.

Neither the maintainer nor the engineer could be called qualified for their jobs on the motor car. In fact, neither of them was particularly interested in their job and, no matter how much time they put in on it, would ever be really good. Anderson knew that, yet if he disqualified either or both, others perhaps no better would be forced on the job and he'd have to start all over again. Saturday he pronounced both men qualified for their jobs and left the motor car with them. He salved his conscience with the thought that at least they were probably as good as they'd ever be.

Some men work better without supervision, needing only the incentive of a job to be done to stimulate their best efforts. Other men of less initiative become lax when left to their devices.

Baker was of the latter and larger class. Not exactly lazy nor indolent, but just a little careless and with a tendency to drag unless prodded occasionally.

After Anderson left, the motor car maintainer and his helper were left severely alone with no one to suggest that if certain things were done in time future trouble might be avoided. Bob Parker, the night foreman, seldom went near the motor car. If they had trouble with it, as he expected, he wanted to be out from under the responsibility of having anything to do with it. Evans saw the car only as it left each morning.

The car went along fairly well a few days following the departure of the supervisor. The car was in pretty good shape and only routine maintenance was required to keep it running. Baker's helper attended to changing the lubricating oil, filling the radiator, and servicing the car in general. The maintainer puttered around, mostly interested in getting in eight hours each night with as little inconvenience to himself as possible. His motto was that the car made one trip all right, it ought to make another.

The theory might be good but it didn't work so well in practice. Deferred maintenance like borrowed money accumulates interest and the motor car was no exception. Bearings became worn, allowing the oil pressure to drop. Rings became worn, causing the engines to lose power. The engineer didn't know what the trouble was. All he knew was that he had to work the engines harder to make the time and in many cases didn't make it then. If he had a couple of extra stops to make or was delayed a few minutes sawing by a freight, it was impossible to make up the lost time.

"Don't you think we'd better take up the bearings on the number two engine?" the maintainer's helper suggested one night. "They're pretty loose," he added.

Baker looked them over and decided that the helper was right. "We'll tighten a couple of them tonight and get the others tomorrow." He took a couple of shims out of the bearings. They still seemed a trifle loose and he took out two more and drew the nuts up tight.

"Pretty tight, ain't they?" the helper said.

"No, they ought to go all right. They'll be O. K. after they limber up a little."

An extra chair car was added to the train next morning. A presidential candidate was speaking in Sanford that afternoon and an unusual number of passengers was expected.

It happened eighteen miles out of Plainville. Both bearings went out. Tight as they were they might have made it if broken in gradually and with oil pressure up to normal. Other bearings in the engine being loose allowed the oil to escape and relieve the pressure. The tight bearings that needed it most didn't get the oil. Metal rubbed against metal instead of on the protecting film of oil.

The train was pulling up the hill out of Clear Creek bottom. Throttles were wide open. The engineer was leaning forward as though he would help the pounding engines pull the load up the hill. Stewart glanced at the voltmeter and the speed indicator. He made a motion to shift the controller to series position but hesitated. About two hundred yards more and the car would nose over the hill.

As his hand paused on the controller handle there was an unfamiliar rattle mingled with the roar of the exhausts and clatter of the engines. The engineer closed the throttle a couple of notches. The laboring car slowed down and he again opened the throttle wide. There was an unmistakable pound of metal against metal.

Stewart looked back at the engines with an inquiring gaze. Then he saw the oil gauge for the number two engine. Pressure had dropped almost to zero. Twenty-five more yards and the train would be over the hill. It made it over but not much farther. With one engine pulling, the car stalled on the next grade. The conductor walked four miles to the nearest telephone and called the dispatcher, while impatient passengers fumed and fretted at the delay. Most of them that had bought tickets swore to never go by train again, especially if the train was pulled by a motor car.

The crank shaft in the number two engine was ruined. The motor car was laid up ten days waiting for a new one and putting it in. Anderson went to Plainville presumably to oversee the job of repairing the engine. He did most of the work.

When the master mechanic learned what had happened he broke his own altitude record. When told how much it was going to cost to put the car in shape and suitable for service, Evans thought that worthy official was going to have apoplexy.

Both the engineer and the maintainer were called in on the carpet to explain why the bearings had burned out. Stewart admitted that he had not reported the bearings on the previous trip. Baker said that he had examined them when the car came in and they were apparently O. K. He neglected to say that he had tightened the bearings the night before the car went out.

"Well, dammit, what caused the trouble? Anderson, can you tell?"

The motor car supervisor hesitated before replying. "Well, if the bearings were O. K. when the car went out, I can't say just what caused it. I've examined the oil pump and lines, they're all right, and the strainer wasn't stopped up. Looks to me like the bearings were too tight, but Baker says he looked at them."

The maintainer flushed. "Yeah, I looked at 'em. That oil we've been getting lately don't look so good," he added.

"I'll have the oil tested," Anderson said, "but it's the same as we're using everywhere."

"Don't you have trouble anywhere but here?" Carter asked testily.

"Yes, we have trouble at other places, too, but not so much some places as others. Some maintainers and engineers seem to have more success maintaining and running the cars than others."

"I don't want to run the blamed car," Stewart flared. "Give me a locomotive every time!"

"You qualified the men yourself," Carter reminded. "If they're not competent, you're the responsible one."

Anderson raised up in his chair, then settled back. No use arguing with the master mechanic. What he wanted to tell him was that the whole set-up regarding motor cars was wrong.

Steam training doesn't fit a man to run a motor car any more than his having been a motorman on a street car qualified him to run a locomotive. As far as maintainers are concerned, it is more a matter of luck than circumstance when by chance a good one is acquired."

The motor car supervisor wanted to tell the master mechanic that and more. He wanted to tell him that for proper and economical service motor cars should be maintained by men especially trained to maintain motor cars, not steam locomotives, and operated by men trained for the purpose. He wanted to tell him about the lack of proper supervision of motor car maintenance and operation, but he didn't. He knew it wouldn't do any good.

Sixty days later the superintendent of motive power heeded Carter's importunities and sent the motor car to another division.

"I'm blamed glad to see it go," Carter said. "The damned things are always giving trouble and are expensive to maintain."

Jim Evans took a fresh chew of horseshoe when he got the message that the motor car was being taken away, and remarked, "Well, I guess we'll have to find some other excuse for our M. of E. charges running over now."

Treating Railway Water

(*Continued from page 409*)

duced to a safe operating degree, very satisfactory results are being obtained. This method is particularly adapted to small water supplies as well as large supplies where the hardness in the natural water or local conditions do not justify the expense of complete treatment.

Boiler compounds have been used for many years, and it is a matter of record in the past that the use of such material in a haphazard way was an aggravation rather than a help in maintaining a satisfactory boiler condition. The intelligent use of a legitimate boiler compound has a decided field in railway water service. Such a compound should only be used after a complete survey has been made of the water situation, the required treatment determined beforehand and formulated accordingly. The old "mystery formulae" are not to be considered by anyone having the interest of railroads at heart.

All of the railroads have found by experience that improving the locomotive water supply results in a large return on the investment. Water treatment has been a vital factor in the extension of locomotive runs, increased fuel mileage, elimination of engine failures and a general reduction in the cost of fuel and enginehouse expense. The actual expenses made for the necessary chemicals are returned many times in the course of a year.

Water treatment without full co-operation of the mechanical department is a difficult problem. When a program of improvement in water supply is contemplated, the engineering forces should co-operate completely with the mechanical forces, and the responsibility for treatment and results should be centralized.

After a program of improvements has been installed, the operation of the softening plants, as well as the instructions and education of all of the mechanical forces, including the men operating the locomotives and those

who have charge of boiler washing, etc., should be such that all are thoroughly familiar with what is occurring when the water supply has been changed to eliminate trouble due to unsuitable water.

The railroad managements are keenly alive to the improved and economical conditions resulting from an intelligent solution of this problem, and by friendly co-operation of mechanical and engineering forces, operating delays and trouble chargeable to water conditions can be successfully eliminated.

When engine crews become familiar with treated water and its action in a boiler, they have no trouble handling locomotives under the most severe operating conditions. Properly treated water will not cause crown sheet trouble or any other trouble in locomotive operation. Water treatment is a common-sense solution to unsuitable water troubles, and very gratifying results are obtained by common-sense methods.

Latest Developments in Shielded Arc Welding*

By A. M. Candy

Those who have been concerned with welding for several years can recall the early days when we had to weld with any old kind of wire we could get our hands on. Swedish iron wire at one time was supposed to be the best thing available. It was quite customary to pick up any coil of wire and cut a chunk out of it. In a great many cases, bail haywire was used, and the results were naturally none too satisfactory. That is the origin of the term "haywire." When you apply it as a welding term, you mean that the job has failed.

Many years ago, in England and other European countries, covered electrodes were developed, but they did not find very extensive use in this country for a good many years. Later it was realized in this country that if welding science was to progress, better results would have to be obtainable. Covered electrodes were developed, therefore, which have resulted in a very high degree of satisfactory performance today. Probably the latest development in covered electrodes is the development of a rod having a coating on it that gives the desirable ductility and tensile strength and at the same time permits that rod to be used on the negative side of the arc; in other words, the same polarity that has in the past given the best results when a bare electrode was used. That of itself can be a very distinct advantage, especially in some particular cases.

For example, covered electrodes naturally cost more to make than the so-called bare electrodes. So if one has a job that can be performed satisfactorily with a bare electrode, in some cases at least, welding work can be carried out somewhat less expensively than it can be using covered electrodes. Therefore, if in a combination job it is desirable to switch from a bare rod to a covered rod, it is naturally helpful at least to be able to stick the rod in the electrode holder and proceed without having to think about going back to the machine and throwing a reversing switch or whatever might be necessary. For this reason, the development of the negative covered rod is probably one of the outstanding developments of the recent months.

One of the other later developments in the covered electrode field is that of developing electrodes which can be used in any position. The earlier electrodes of the shielded arc type which were developed worked fine for downward welding in a flat position, but when it came to vertical work and overhead work they were not satisfactory at all. Further research and investigation and testing resulted in the development of electrodes which are satisfactory for vertical work as well as overhead work. [Mr. Candy here showed about 50 slides of typical railway shop electric-welding operations. In discussing the practice of welding cracked driving wheel spokes at the Illinois Central shops, Paducah, Ky., Mr. Candy made the statement given below.—EDITOR.]

The welding work is done with the covered electrode, and naturally in welding over the side of the spoke a certain amount of tear drop material rolls over and accumulates, and the finished job must be smooth, so the welders take advantage of one of the peculiarities of the covered electrode plus the very good long-arc characteristics of our modern welding machines and by turning the current up a little bit and holding a long arc they can smooth that whole mass down as well as if ground with an emery wheel, and that saves considerable money.

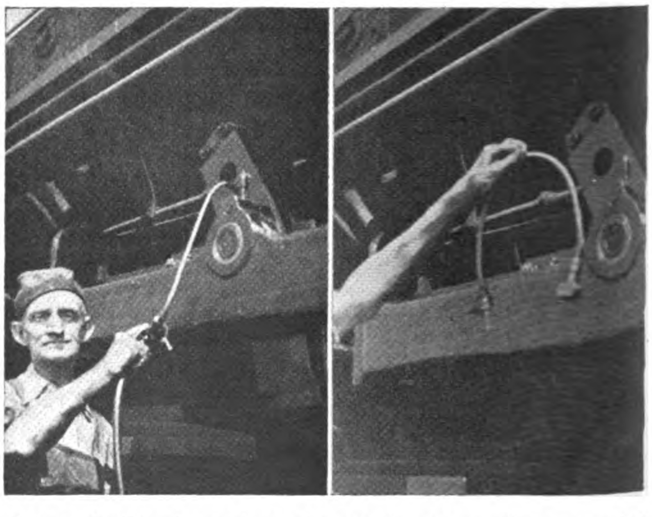
* Presented by A. M. Candy, Consulting engineer, Hollup Corporation, at the Midwest Welding Conference, held by this company at Chicago on June 5.

Filling Link Blocks With Soft Grease

By James E. King

The arrangement illustrated provides a simple and easy method of lubricating the link blocks of a locomotive on which soft grease is employed as a lubricant—a practice now quite generally followed. Where this device is used, the link blocks are provided with a permanent grease cavity or are fitted with grease cups.

The device itself consists of a piece of flexible pipe, about 2 ft. long, one end of which is provided with a receptacle for connection to the long hose leading to the portable grease tank and the other end provided with a slide attachment which drops over the grease cup on the top of the link block. Then, after coupling the attachment to the grease hose, a few strokes of the pump are sufficient to fill the link-block receptacle with grease. The reverse lever in the cab does not need to be touched provided the block has not been moved to the top of the link. If in any other position the device can be used with a considerable saving in time and labor. This device has been used satisfactorily for a number of years.



A short flexible pipe with suitable attachments provides a convenient means for filling link-block grease cups

Among the Clubs and Associations

Central Railway Club of Buffalo.—"Why Federal Inspection?—One Quarter of a Century or Twenty-Five Years of Locomotive Inspection by the Federal Government" will be discussed by John M. Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C., before the meeting of the Central Railway Club of Buffalo to be held on September 10 at 8 p.m., daylight saving time, at the Hotel Statler, Buffalo, N. Y.

Car Foremen's Association of Chicago.—O. E. Ward, general superintendent of motive power of the Chicago, Burlington & Quincy, will lead in the discussion of maintenance of coal carrying equipment which will follow the presentation of "The Story of a Famous Coal" by the Bell & Zoller Coal Company at the meeting of the Car Foremen's Association of Chicago to be held at 8 p.m., eastern standard time, on September 14 at the La Salle Hotel, Chicago. Moving pictures will be used to illustrate the story on coal.

Traveling Engineers' Association.—The fortieth annual meeting of the Traveling Engineers' Association will be held on September 15 and 16 at the Hotel Sherman, Chicago. Six subjects will be discussed at this meeting: (1) Of What Benefit Is the Road Foreman or Traveling Engineer to the Railroads?; (2) What Has Been Accomplished by Extended Locomotive Runs?; (3) Progress in Draft Appliances and the Effect on Present-Day Locomotives; (4) Brakes as Used on Streamline Trains, Gas or Oil or Electric, Handling and Operating and Maintenance; (5) New Super Speed Passenger Locomotives, and (6) the question of the amalgamation of the Traveling Engineers' Association and the International Railway Fuel Association.

American Welding Society.—The seventeenth annual meeting of the American Welding Society will be held on October 19-23, inclusive, at the Hotel Cleveland, Cleveland, Ohio. On Thursday, October 22, there will be joint sessions of the American Welding Society with the American Society of Mechanical Engineers, at which the following papers will be presented: Stress Analysis, by C. H. Jennings, Westinghouse Electric & Manufacturing Co.; Alloy Steels and Their Weldability, by A. B. Kinzel, Union Carbide and Carbon Research Labs.; Welding Heavy Machinery and Equipment, by C. A. Wills and F. L. Lindemuth, Wm. B. Pollock Company; Steel Plate Construction, and Using Steel Plates for Machine Frames. At sessions on Friday, October, 23, to which American Welding Society members are invited, members of the American Society of Mechanical Engineers will discuss the Weldability of Non-Ferrous Metals—copper, brass and bronze, monel metal and aluminum. Welding developments as they affect mechanical design will also be discussed, as well as the welding of light machines and products and the principles involved in selecting casting vs. welding. Among other papers to be presented at earlier sessions are: Fundamentals of Metallurgy of Welding by E. S. Davenport and Dr. R. H. Aborn, United States Steel Corporation; The Welding of Copper, by A. P. Young, Michigan College of Mining and Technology; Principles of Surfacing by Welding, by E. W. P. Smith, Lincoln Electric Company, and Thermit Welding, by J. H. Deppeler, Metal & Thermit Corporation. High-speed motion pictures of various welding processes will be shown by E. Vom Steeg, General Electric Company, and W. E. Crawford and Walter Richter, A. O. Smith Corporation. The Metal Congress Exposition will be held simultaneously at the Public Auditorium, Cleveland.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

Air-Brake Association.—T. L. Burton, care of Westinghouse Air Brake Company, 3400 Empire State Building, New York.

Allied Railway Supply Association.—F. W. Venton, Crane Company, Chicago.

American Railway Tool Foremen's Association.—G. G. Macina, 11402 Calumet avenue, Chicago.

American Society of Mechanical Engineers.—C. E. Davies, 29 West Thirty-ninth street, New York.
Railroad Division.—Marion B. Richardson, 192 East Cedar street, Livingston, N. J.
Machine Shop Practice Division.—G. F. Nordenholt, 330 West Forty-second street, New York.
Materials Handling Division.—F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.
Oil and Gas Power Division.—M. J. Reed, 2 West Forty-fifth street, New York.
Fuels Division.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

Association of American Railroads.—J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.
Division I.—Operating.—Safety Section.—J. C. Caviston, 30 Vesey street, New York.
Division V.—Mechanical.—V. R. Hawthorne, 59 East Van Buren street, Chicago.
Committee on Research.—E. B. Hall, chairman, care of Chicago & North Western, Chicago.
Division VI.—Purchases and Stores.—W. J. Farrell, 30 Vesey street, New York.
Division VIII.—Motor Transport.—Car Service Division.—C. A. Buch, Transportation Building, Washington, D. C.

Association of Railway Electrical Engineers.—Jos. A. Andreucetti, C. & N. W., 1519 Daily News Building, 400 West Madison street, Chicago, Ill. Annual meeting, October 27-29, Hotel Sherman, Chicago.

Canadian Railway Club.—C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

Car Department Officers' Association.—A. S. Sternberg, master car builder, Belt Railway of Chicago, 7926 South Morgan street, Chicago.

Car Foremen's Association of Chicago.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

Car Foremen's Association of Omaha, Council Bluffs and South Omaha Interchange.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p. m.

Central Railway Club of Buffalo.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

Eastern Car Foremen's Association.—E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

Indianapolis Car Inspection Association.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

International Railway Fuel Association.—T. D. Smith, 1660 Old Colony Building, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 West Wabasha street, Winona, Minn.

International Railway Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

Master Boiler Makers' Association.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting, September 16 and 17, Hotel Sherman, Chicago.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September, at Copley-Plaza Hotel, Boston.

New York Railroad Club.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July, August and September, at 29 West Thirty-ninth street, New York.

Northwest Car Men's Association.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, University and Prior avenue, St. Paul.

Pacific Railway Club.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately—June in Los Angeles and October in Sacramento.

Railway Club of Greenville.—J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

Railway Club of Pittsburgh.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

Railway Fire Protection Association.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md.

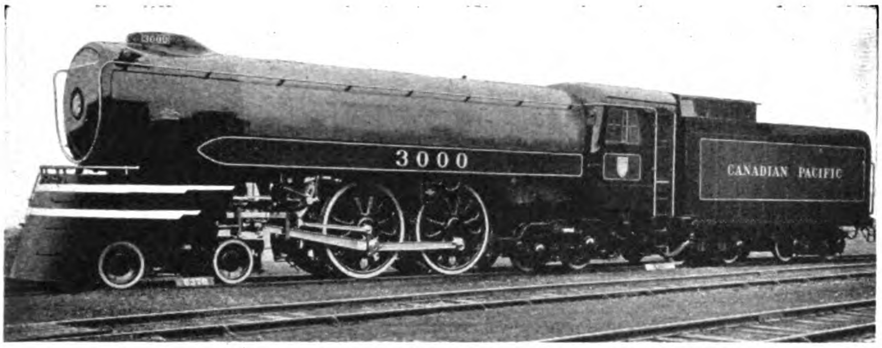
Railway Supply Manufacturers' Association.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

Southern and Southwestern Railway Club.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

Toronto Railway Club.—R. H. Burgess, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month except June, July and August, at Royal York Hotel, Toronto, Ont.

Traveling Engineers' Association.—Miss E. Earl, acting secretary, 10213 Hampden avenue, Cleveland, Ohio. Annual meeting, September 15 and 16, Hotel Sherman, Chicago.

Western Railway Club.—C. L. Emerson, executive secretary, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.



First Canadian Pacific "Jubilee" locomotive, built by the Montreal Locomotive Works

This locomotive, one of five for high-speed passenger service, was delivered to the Canadian Pacific in a formal and colorful ceremony on Monday, July 27. It is of the 4-4-4 type. The boiler carries a working pressure of 300 lb. per sq. in.; the cylinders are 17¼ in. by 28 in.; the driving wheels, 80 in. in diameter, and the tractive force, 26,500 lb. The total weight of the engine is 263,000 lb. It is known as the Jubilee type in celebration of the fiftieth anniversary year of the establishment of transcontinental passenger service by the Canadian Pacific.

NEWS

Pneumatic-Tired Rail Cars in Great Britain

THE London, Midland & Scottish of Great Britain is experimenting with pneumatic-tired rail motor cars, according to a recent statement from the Associated British Railways, Inc., New York. The cars, with capacity for 56 passengers, have 16 pneumatic-tired wheels. Each is powered with a 275-hp. gasoline engine designed for a cruising speed of 60 m.p.h., with a maximum speed of about 75 m.p.h. The cars are described as "faster and more powerful than any single car units ever tested in Great Britain." Also, they carry new experimental equipment designed to operate signaling track-circuits and fog detonators.

Foot-Warmers and Arm Chairs for Brakemen

Now that the Pullman surcharge has been abolished and passengers are being furnished with better seating and other facilities at lower rates, the railroad brakemen are demanding better service also and some of the facilities of the driver of the private automobile with which the railroads, or at least the Interstate Commerce Commissioners, are trying to compete.

A. F. Whitney, president of the Brotherhood of Railroad Trainmen, has filed with the Interstate Commerce Commission a complaint asking it, as a safety measure, to require the railroads to equip their locomotives with "proper and adequate" seating facilities for all members of train crews who are required to ride upon locomotives or the head ends of trains. These seating facilities are to be equipped with spring cushions and spring cushion back rests, foot warmers, and padded arm rests, and where there is only one window on the fireman's side of the cab the commission is asked to require two windows, one for the forward brakeman and one for the fireman. In addition the commission is asked to require that hot steam pipes on the right side of the engine boiler be removed and placed back of the locomotive boiler head so as to prevent injury to employees from burns.

The present seating arrangement for head brakemen, the complaint says, "endangers the health, comfort, and general welfare of trainmen by unduly exposing them to extreme weather conditions, unnecessary danger and hazard in the event of an explosion in the firebox," and it is also said to endanger travelers upon the highways by rendering trainmen incapable of keeping an effective lookout, although in a proceeding now pending before the commission on a complaint of the enginemen's brotherhoods the firemen ask to be relieved of firing by the installation of automatic stokers so that they may keep a steady lookout.

New Equipment in Order

MORE new freight cars were on order by Class I railroads of the United States on July 1, this year, than on any July 1 since 1929, according to the Association of American Railroads. Orders for new freight equipment on July 1 called for 28,089 cars, compared with 2,428 new freight cars on July 1, 1935, and 17,813 cars on July 1, 1934. On July 1, 1929, equipment orders included 39,638 new freight cars. New freight cars on order on June 1, this year, totaled 25,748.

New locomotives on order July 1, included 67 steam and 23 of the electric and Diesel types, compared with six steam locomotives and 22 electric locomotives on order on July 1, 1935; and 40 steam and 107 electric locomotives on order July 1, 1934. New steam locomotives on order on June 1, this year, totaled 58, and new electric and Diesel locomotives 30.

New freight cars placed in service in the first six months this year totaled 11,604, compared with 1,868 in the corresponding period of 1935 and 5,362 in the same period of 1934. Eighteen new steam locomotives and 11 new electric and Diesel locomotives were placed in service in the first half of this year, compared with 25 steam and 81 electrics commissioned in the first six months of 1935, and one steam and eight electrics placed in service the first half of 1934.

Industrial Research

THE Subcommittee on Industrial Research of the Engineering Foundation Welding Research Committee held a two-day session, July 23-24, at Watertown Arsenal, Watertown, Mass. Col. G. F. Jenks, commanding officer of the Arsenal and chairman of the Subcommittee, presided at the various sessions. He stated that the purpose of the conference was to complete the organization of the sub-subcommittees preliminary to the analysis of research activities being conducted to solve the many complicated problems in the welding field.

The work was divided among various sub-subcommittees, including the following material sub-subcommittees: Cast Iron, Carbon Steels, Low Alloy Steels, High Alloy Steels, Aluminum Alloys, Copper Alloys, and Nickel Alloys. Functional sub-subcommittees on Methods of Testing, Analysis of Weld Failures, and Weld Stresses—Causes and Effects are being organized.

The two-day session included the presentation of papers and reports on radiography, monel metals, low alloy steels and high velocity impact tests. Members of the Subcommittee had an opportunity to witness various welding operations at the Arsenal, the centrifugal casting of low alloy steel, and the testing of metals under impact loads delivered at the rate of more than 300 ft. a second.

A second conference is planned for the middle of October in Cleveland during the annual convention of the American Welding Society and the Metal Congress Exposition.

Dr. C. E. Adams, chairman of the Welding Research Committee, reported that the Engineering Foundation had made three grants, totaling $12,000, to launch the project and that leaders of industry had pledged whole-hearted co-operation.

Research Advancing Rail Transport, Says Wallace

RESEARCH advancing rail transportation is proceeding on a vast scale, according to L. W. Wallace, director of the Division of Equipment Research of the Association of American Railroads, who declared in a recent statement that "the railroad industry stands on the threshold of one of the most active and fruitful eras of its history." Pointing out that the railroads are purchasers of more than 70,000 commodities, Mr. Wallace asserted that through the network of relationships built up around the transportation system of the United States a very large research per-

sonnel is working directly and indirectly in behalf of the railroad industry.

"These many relationships," he continued, "mean that of the hundreds of millions of dollars spent annually for research by such industries as the steel, chemical, electric, textile, railway supply, and others, a measurable amount is spent directly in response to the needs of the railroad industry. In the last analysis the railroad industry pays a measurable amount of the cost of such research as is devoted to developing the commodities it uses in the price it pays for such commodities."

Mr. Wallace explained that the railroad industry is necessarily confined to applied research as are all others who purchase materials and equipment for their individual use.

"The Division of Equipment Research," he said, "realizes that it would be thoroughly impracticable and inadvisable to have a staff and laboratory facilities adequate in size and quality to deal with the great number of research problems which it will be expected to and must consider. The Division will therefore maintain a relatively small staff and will purchase only such special equipment as may be needed and is not available in some laboratory. As each problem arises it will enlist the services of the best talent and facilities available for such research. Thus, there will continue to be brought to bear upon the railroad research problems the highest degree of scientific and professional talent. Today two of the leading metallurgical research institutions are working on problems assigned to them. Three of the large technical institutions are likewise working on assigned problems. The research program on the air conditioning of railroad passenger cars recently authorized is being so organized that the best research facilities of manufacturers, railroads, and technical universities will be used."

Enumerating other research tasks of the railroads, Mr. Wallace describes the development of the locomotive, stressing the possibilities of the more recently constructed locomotive laboratories of the University of Illinois and the Pennsylvania Railroad.

New Equipment

Locomotive Orders

Road	No. of locomotives	Type of locomotive	Builder
Conemaugh & Black Lick	2*	0-8-0	American Loco. Co.
Mexican National Construction Co.	2†	2-6-6-2	American Loco. Co.
Monessen Southwestern (Pittsburgh Steel Co.)	1‡	0-6-0	American Loco. Co.
Union Pac.	1§	Steam-turbo elec.	General Elec. Co.

Locomotive Inquiries

Road	No. of locomotives	Type of locomotive	Builder
Birmingham Southern	10	Diesel-elec.	....
Carnegie-Ill. Steel Corp.	1	0-4-0	....

Freight Car Orders

Road	No. of cars	Type of car	Builder
Birmingham Southern	100	Box	Pullman-Std. Car Mfg. Co.
	25	Gondola	Pullman-Std. Car Mfg. Co.
Union Tank Car Co.	3,000	6,500-gal. tank	American Car & Fdry. Co.
Youngstown & Northern	100	70-ton gondolas	Greenville Steel Car Co.

Freight-Car Inquiries

Road	No. of cars	Type of car	Builder
Missouri Pacific	200	40-ton box	....

* These locomotives will have 25-in. by 28-in. cylinders and a total weight in working order of 231,000 lb.

† These locomotives will have 15-in. by 22-in. cylinders and a total weight in working order of 216,000 lb.

‡ This locomotive will have 22-in. by 28-in. cylinders and a total weight in working order of 181,000 lb.

§ Briefly described on page 338 of the August *Railway Mechanical Engineer*.

Articulated Pullman Car Ready for Service

THE light-weight streamline two-body articulated passenger car, which the Pullman-Standard Car & Manufacturing Company has had under construction for the Pullman Company, has now been completed and is soon to be placed in service in various regular trains throughout the country so that public reaction to the new features involved may be studied. This car, which is designed for rear-end operation, consists of a sleeping unit containing 16 "duplex" bedrooms arranged in two levels and a combination sleeping and observatory lounge unit.

Following one week's operation on the Twentieth Century Limited of the New York Central and another on the Broadway Limited of the Pennsylvania, the car is being transferred to service on other railroads throughout the country. The car, which is of alloy steel construction with interior trim of aluminum alloy, was described briefly in the May, 1935, issue of the *Railway Mechanical Engineer,* page 212.

"Speed-Endurance" Record Claimed for British Train

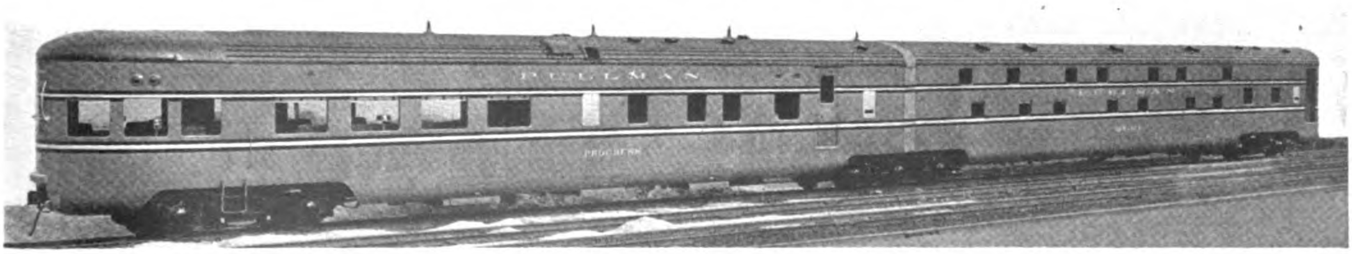
THE London & North Eastern of Great Britain claims for its "Silver Jubilee" the "world's speed-endurance record for steam trains," according to a recent statement issued by the Associated British Railways, Inc., New York. The claim is based on the fact that the Silver Jubilee has recently completed 100,000 miles of high-speed operation in the period of nine months; it has averaged 67.1 m.p.h. on its regular run of 268 miles between Newcastle and London. An analysis of the train's record shows that it has, without loss of time attributable to the locomotive, run 100,000 miles at an average speed of 67.1 m.p.h.; 86,567 miles at 70.4 m.p.h.; and 18,283 miles at speeds "exceeding 80 m.p.h."

Four locomotives are now assigned to the Silver Jubilee—the "Silver Link," the "Silver King," the "Silver Fox" and "Quicksilver." Attention is called to the fact that only one set of cars for the train is available and that these cars have run the 100,000 miles without developing mechanical defects.

Increased Efficiency in Fuel Consumption

FOR each pound of coal consumed in freight service, the railroads of the United States in 1935 hauled 8⅛ tons a distance of one mile, according to a statement issued recently by J. J. Pelley, president of the Association of American Railroads. This was an increase in fuel efficiency of 44 per cent compared with 1920, in which year an average of 5¾ gross tons was hauled one mile for each pound of coal used.

In the past sixteen years, the statement continues, there has been an almost constant increase in efficiency obtained in fuel consumption, both in freight and passenger service, with a substantial saving in the fuel bill of the railroads. The foregoing is attributed by Mr. Pelley to a large number of factors, including improvements in the construction of new locomotives, modernization of older locomotives by equipping them with up-to-date improvements to aid combustion; improved methods of operation to keep trains moving with a minimum number of stops, and the continuing progress in scientific methods of chemically treating boiler water, in order to eliminate so far as possible ingredients harmful to locomotives. Improvements in scientific methods used to determine just which grades of coal are best adapted for locomotives have also contributed to increased fuel consumption efficiency.



Pullman articulated car having bedrooms arranged in two levels and a combination sleeping and observation-lounge unit

Two New Locomotives for the L. & N. E.

Two new locomotives have recently been completed in the shops of the London & North Eastern of Great Britain. One, which has been named the "Green Arrow," is of the 2-6-2 type and has been designed for hauling fast passenger and freight trains; the other, called "Lord President," is of streamline design and will be used for hauling fast passenger trains over the east coast route between Edinburgh and Aberdeen.

The Green Arrow is described as the first locomotive of its class to be built in Great Britain. It has three cylinders 18½ in. in diameter and with a 26 in. stroke, and a total weight in working order of 144 tons. An additional 32 locomotives of this type are to be built in L. N. E. shops.

The Lord President, described as a modification of the "Earl Marischal," comprises with the latter and the "Cock o' the North" the "most powerful passenger locomotives in Great Britain." Its streamlining is similar to that of the "Silver Link" which hauls the L. N. E.'s "Silver Jubilee" train. It has three cylinders, each 21 in. by 26 in., and a total weight in working order of 167 tons. Three other locomotives of this type are under construction. All have been designed by Sir H. N. Gresley, chief mechanical engineer, L. & N. E.

Supply Trade Notes

The Inland Steel Company, Chicago, has established a Chicago district sales office with Leon C. Reed as district sales manager and Otto G. Neumann as assistant district sales manager.

Blake C. Howard has been placed in charge of all railroad business for L. C. Chase & Company, Inc., selling division of Goodall-Sanford Industries in the St. Louis, Mo., area. Mr. Howard's headquarters will be in the Railway Exchange building.

The McIntosh & Seymour Corporation, Auburn, N. Y., a wholly owned subsidiary of the American Locomotive Company, has been merged with the parent company and the business heretofore conducted by that corporation is now carried on by the American Locomotive Company, Diesel Engine Division, Auburn. In the merger the American Locomotive Company has acquired the assets of the McIntosh & Seymour Corporation, including the manufacturing plant at Auburn, sales orders and contracts, and the operating, sales and administrative personnel, and has assumed all the liabilities, including contracts and orders for the purchase of materials and supplies. Robert B. McColl, president of the McIntosh & Seymour Corporation, has been appointed vice-president of the American Locomotive Company, Diesel Engine Division, and Henry T. Sherman, John Thomas and Heinrich Schneider have been appointed assistant vice-presidents. The Diesel Engine Division of the American Locomotive Company will continue to build and supply the complete line of McIntosh & Seymour four-cycle Diesel designs. There has also been added the two-cycle Diesel designs of Sulzer Brothers, Winterthur, Switzerland, to be built and sold in America under the trade name Alco-Sulzer.

The Fulton Sylphon Company, Knoxville, Tenn., specialists in temperature controlling equipment, has formed a Railway Equipment Division, with headquarters in the Drexel building, Philadelphia, Pa. This division, headed by Thomas Kenny, will concentrate upon serving railroad air-conditioning control requirements.

W. G. Robbins, vice-president and general sales manager of the Carboloy Company, Inc., has been elected president to succeed Dr. Zay Jeffries, who became chairman of the board upon the retirement of P. R. Mallory. A. MacKenzie, manager of manufacturing, has been elected vice-president in charge of manufacturing; K. R. Beardslee, Pittsburgh district sales manager, has been appointed general sales manager of the Carboloy Company; J. R. Longwell, die engineer, has been appointed chief engineer, and A. A. Merry, Cleveland district sales manager, has been appointed special representative in charge of activities with agents licensed to supply Carboloy on their tools, dies and machines. A. H. Godfrey has been appointed Cleveland district manager, and P. W. Weieser becomes manager of the Pittsburgh district.

Frank H. Hardin, whose election to the presidency of the Association of Manufacturers of Chilled Car Wheels to succeed J. A. Kilpatrick was announced in the August issue of the *Railway Mechanical Engineer*, was born in Gainesville, Ga., on June 14, 1886, and in 1908 he was graduated from the Georgia School of Technology with a degree of Bachelor of

Blank-Stoller, Inc.

F. H. Hardin

Science in Mechanical Engineering. After postgraduate work at Columbia University, New York, Mr. Hardin entered railroad service in 1909 as a special apprentice on the New York Central, his entire railroad career having been in the service of that road. From 1912 until 1914 he was successively assistant enginehouse foreman and enginehouse foreman; and during the three following years, until 1917, he was special engineer to the office assistant to the president. In 1917-18 Mr. Hardin was master mechanic at Utica, N. Y., becoming in the latter year assistant to the federal manager, a position which he retained until 1920. Next he was chief engineer of motive power and rolling stock, a position which he held until 1926, the year of his appointment as assistant to the president. Mr. Hardin has been a member of the General Committee of the Mechanical Division, Association of American Railroads, continuously since 1924. He is a member of the A. S. M. E.

A. R. Ellis, vice president and director of the Pittsburgh Testing Laboratory, has been elected president, retaining also his directorship. Mr. Ellis was born in Pittsburgh, Pa., and educated in the public schools of that city. He is a graduate of Cornell University, Ithaca, N. Y., where he obtained the degree of civil engineer in 1905. During the same year he became a laboratory technician in the employ of the Pittsburgh Testing Laboratory, later becoming an inspector of engineering materials and finally, in 1910, chief engineer. In 1917 he was appointed manager of the New York branch of the Pittsburgh Testing Laboratory; in 1918, assistant general manager; in 1921, general manager and director, and in 1929, vice-president and director. Mr. Ellis is a member of a number of technical societies, including the American Society of Civil Engineers; American Society for Testing Materials; American Welding Society, and the American Institute Steel Construction.

Thomas Cruthers, assistant vice-president in charge of sales, has been appointed vice-president of the Worthington Pump & Machinery Corporation, Harrison, N. J. Mr. Cruthers was graduated from Stevens Institute of Technology with the degree of mechancial engineer and then entered the employ of the Westinghouse Machine Corporation, serving as superintendent of gas engine erecting. In 1907, in the same capacity, he entered the service of the Snow Steam Pump Works, a Worthington subsidiary, at Buffalo, N. Y. In 1908 he was transferred to the Worthington sales department in the Pittsburgh district, and subsequently to various other district offices until 1927, when he was appointed New York district sales manager. Three years later he was appointed assistant general sales manager and two years later became assistant vice-president in charge of sales. Mr. Cruthers will direct the corporation's sales activities in the steam power stations, railroad, waterworks and sewage fields and will also have charge of the general traffic department.

(*Turn to next left-hand page*)

Paul C. Cady, who has been elected vice-president in charge of sales for the eastern district of the Union Railway Equipment Company, Chicago, with headquarters in New York, was educated at Baldwin University Law School and began

Bachrach

Paul C. Cady

his railway career in the mechanical department of the Lake Shore & Michigan Southern at Cleveland, Ohio. Later he was employed in the mechanical department of the New York Central at New York, and in 1919 resigned as assistant to the chief mechanical engineer of this road, to enter the railway supply business. Since that time he has been engaged in the railway supply business in New York, at the present time also being president of the Midland Supply Company.

Obituary

O. H. Mellum, assistant vice-president of the American Car & Foundry Company, with headquarters at Chicago, was killed in Lake Bluff, Ill., on August 14, when he was struck by a train while alighting from another train at that station.

Robert J. Sharpe, manager of sales of the General American Tank Car Corporation for the Tulsa district, died suddenly at Palmer Lake, Colo., on July 27. Mr. Sharpe had been connected with this company for 25 years.

John W. Kincade, who invented one of the first automatic locomotive stokers, died at his home in Cincinnati on July 31, at the age of 68. While working as a locomotive engineer on the Chesapeake & Ohio he devised a stoker, which was at first worked by hand, but later by steam. Several were used on this road with the long firebox locomotives, but were discontinued when the wider firebox design was introduced. The stoker was improved and became known as the Day-Kincade, and later on as the Victor, but never got beyond experimental use.

John C. Whitridge, president and general manager of the Buckeye Steel Castings Company, died at Columbus, Ohio, July 29. Mr. Whitridge was 64 years of age and a native of Richmond, Ind. He received his higher education at Purdue University, graduating in mechanical engineering with the class of 1895. After leaving college, he became associated with D. L. Barnes, a consulting engineer at Chicago, and subsequently became connected with the editorial staff of the Railroad Gazette (now incorporated in the Railway Age). In 1902 he joined the Buckeye Steel Castings Company as assistant general manager; in 1920 was appointed vice-president, and in 1927 became president and general manager. The introduction of steel castings for automatic car couplers and for railroad car trucks were developments that took place during Mr. Whitridge's association with the Buck-

John C. Whitridge

eye Steel Castings Company. From 1912 to 1915 he was a member of the Executive Committee of the Railway Supply Manufacturers Association, and at the time of his death he was treasurer and a trustee of the Ohio Manufacturers Association.

Personal Mention

General

C. P. Dampman, supervisor of fuel conservation of the Reading, at Philadelphia, Pa., has been granted an indefinite leave of absence on account of illness.

N. M. Trapnell, special engineer of the Chesapeake & Ohio at Richmond, Va., has been appointed mechanical engineer, succeeding E. R. Hauer, transferred.

J. M. Kerwin, superintendent motive power of the Chicago, Rock Island & Pacific, with headquarters at Silvis, Ill., has moved his headquarters to Kansas City, Mo.

H. Morris, superintendent fuel and locomotive performance of the Central of New Jersey at Jersey City, N. J., has had his jurisdiction extended to include the Reading Company.

F. L. Crissey, general shop foreman of the Denver & Rio Grande Western at Salt Lake City, Utah, has been appointed assistant mechanical superintendent, with headquarters at Denver, Colo.

H. W. Cathcart has been appointed assistant superintendent fuel and locomotive performance of the Central of New Jersey and the Reading, and the position of fuel inspector of the Reading has been abolished.

Walter E. Sample, supervsior of locomotive operation of the Baltimore & Ohio at Pittsburgh, Pa., has been appointed assistant to chief of motive power and equipment, succeeding F. Kirby, deceased.

J. E. Davenport, assistant to vice-president and general manager of the New York Central System, has been appointed assistant chief engineer motive power and rolling stock, with headquarters at New York.

John Pfeiffer, superintendent motive power of the Ft. Worth & Denver City, has been appointed also to the position of superintendent of motive power on the Colorado & Southern to succeed H. W. Ridgway, who has retired. Mr. Pfeiffer will maintain offices at both Denver, Colo., and Childress, Tex.

P. C. Withrow, mechanical engineer of the Denver & Rio Grande Western, has been appointed acting general mechanical superintendent, with headquarters as before at Denver, Colo., succeeding W. J. O'Neill, whose appointment as superintendent motive power of the Western Pacific was reported in the July issue of the *Railway Mechanical Engineer.*

H. W. Ridgway, superintendent of motive power of the Colorado & Southern, with headquarters at Denver, Colo., retired on August 1. Mr. Ridgway was born on July 17, 1866, at Delaware Water Gap, Pa., and entered railway service in November, 1881, as a mechanical apprentice on the Denver & Rio Grande, serving in various capacities in the mechanical departments of this company and of the Mexican Central until 1901 when he was appointed superintendent of machinery of the El Paso & Northeastern (now part of the Southern Pacific), later being appointed superintendent of the contract shop. In 1904 he returned to the Mexican Central as superintendent of shops at Aguas Calientes, Mex., and from 1906 to 1913 served as master mechanic on the Colorado & Southern and the Atchison, Topeka & Santa Fe at Denver. At the end of this period he was appointed superintendent of motive power of the C. & S. From 1924 to 1932 he also served as assistant to the superintendent of motive power of the Chicago, Burlington & Quincy.

Master Mechanics and Road Foremen

W. P. Primm has been appointed assistant road foreman, Baltimore division, of the Pennsylvania.

J. T. Slaven, master mechanic of the Coast division of the Southern Pacific, at Bayshore, Cal., has been retired.

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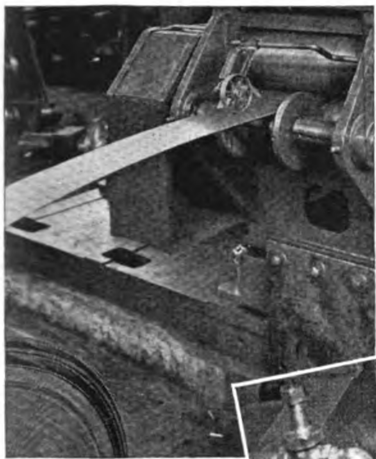

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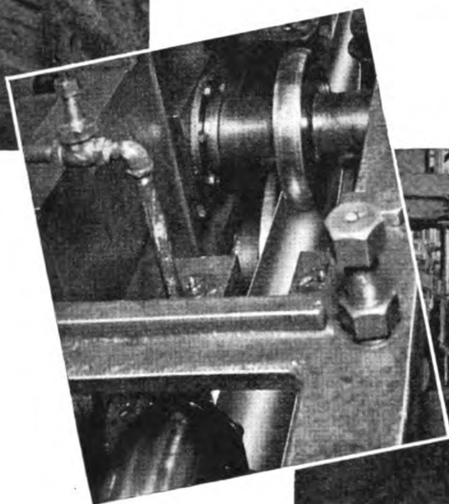

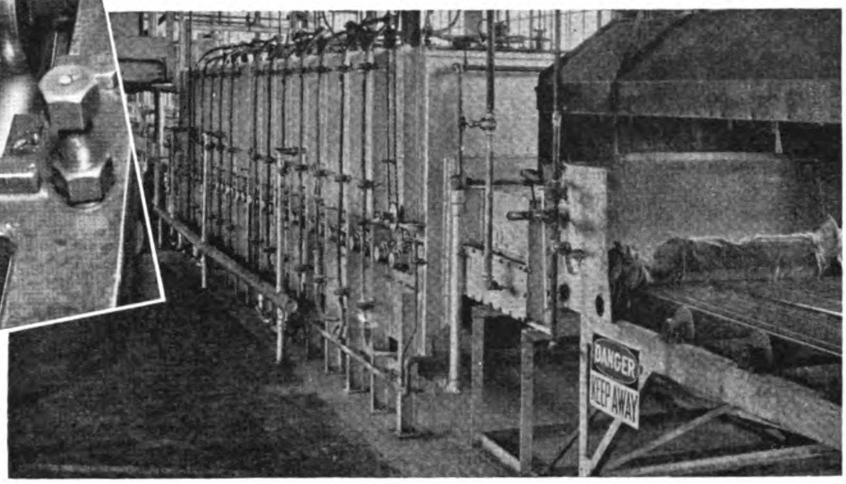

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B. W. Johnson, assistant road foreman of engines, Baltimore division, of the Pennsylvania, has been appointed assistant road foreman of engines, New York Division.

A. B. Wilson, master mechanic of the Portland division of the Southern Pacific at Brooklyn, Ore., has been transferred as master mechanic to the Coast division to replace J. T. Slaven.

F. A. Schilling has been appointed master mechanic of the Portland division of the Southern Pacific, with headquarters at Brooklyn, Ore., succeeding A. B. Wilson.

M. F. Smith, enginehouse foreman of the Atchison, Topeka & Santa Fe at Los Angeles, Cal., has been appointed acting master mechanic of the Arizona division, with headquarters at Needles, Cal., succeeding R. Tuck, transferred.

Shop and Enginehouse

H. T. Clark, road foreman of engines of the Baltimore Division of the Baltimore & Ohio, has been appointed supervisor, locomotive operation, with headquarters at Pittsburgh, Pa., succeeding W. E. Sample.

Laurence C. Bowes, general piece work supervisor of the Chicago, Rock Island & Pacific, has been promoted to the newly created position of engineer of shop plants and machinery, with headquarters as be-

Laurence C. Bowes

fore at Chicago. Mr. Bowes was born on June 23, 1890, at Minneapolis, Minn., and received his higher education at Cornell university. He entered the service of the Rock Island in July, 1916, as inspector of stationary boiler plants, serving in this capacity until December, 1922, except for a period during the World War when he was in military service, serving as a private and sergeant overseas. At the end of this period he was promoted to production engineer, and on July 1, 1926, was appointed general piece work supervisor.

Purchasing and Stores

Guy O. Beale, whose appointment as chief purchasing and stores officer of the Chesapeake & Ohio, the New York, Chicago & St. Louis and the Pere Marquette was reported in the August *Railway Mechanical Engineer,* has been connected with the C. & O. for about 26 years. He was born on September 24, 1888, at Ettricks, Va., and after a business college education, he attended the law school of the University of Richmond. He entered the service of the C. & O. in April, 1908, as a clerk in the master mechanic's office, becoming a statistician in the mechanical department

Guy O. Beale

in February, 1914. From September, 1917, to June, 1919, Mr. Beale was in military service with the United States Army, then resuming his position with the C. & O. as a statistician in the mechanical department. In March, 1925, he was appointed chief clerk in the mechanical department and in April, 1927, was transferred to the operating department as assistant chief clerk, being appointed assistant chief clerk to the president in April, 1929. In September of the same year Mr. Beale was appointed chief clerk to the late W. G. Black, then mechanical assistant to the president of the C. & O. and the P. M. In November, 1931, when Mr. Black was appointed assistant vice-president (mechanical, purchases and stores), Mr. Beale became his assistant. In April, 1933, when Mr. Black was appointed vice-president in charge of purchasing, stores and mechanical matters of the C. & O., Nickel Plate and P. M., Mr. Beale continued as his assistant, holding this position until his appointment as chief purchasing and stores officer, with headquarters at Cleveland.

E. J. Clark, chief lumber inspector of the Chicago Burlington & Quincy at Chicago, has been appointed storekeeper at Sheridan, Wyo.

Hal D. Foster, purchasing agent of the Colorado & Southern, with headquarters at Denver, Colo., has been appointed also purchasing agent of the Burlington-Rock Island.

Obituary

Gerhardt E. Fluth, division storekeeper on the International-Great Northern, with headquarters at San Antonio, Tex., died on July 29 in that city, at the age of 44 years.

Bernard J. Feeny, traveling engineer of the Memphis Division of the Illinois Central, with headquarters at Memphis, Tenn., died on May 31 after an illness of several months. Mr. Feeny was born on November 21, 1875, in Chicago. He began his railroad career on October 11, 1895, as a locomotive fireman on the Chicago Terminal. Three years later he became an engineer and in 1903 was promoted to the position of traveling engineer of the Kentucky division, with headquarters at Paducah, Ky. On July 14, 1913, he was transferred to the Memphis Terminal at Memphis as traveling engineer. On June 16, 1918, he was appointed supervisor of fuel conservation—director of operation, United States Railroad Administration, Southern Region, with headquarters at Atlanta, Ga., and on March 1, 1920, when the railroads were turned back to private ownership, he returned to Memphis as traveling engineer. In 1923 he served as a member of the Examination Board on Rules in the Transportation Department, and from August 16, 1926, to February 15, 1930, was superintendent of fuel conservation, Illinois Central System, with headquarters at Chicago. Mr. Feeny was an authority on fuel conservation and smoke abatement and a member of the American Railway Fuel Conservation Association and the Traveling Engineers' Association, being president of the latter from 1916 to 1918.

Samuel Lynn, superintendent rolling stock, Pittsburgh & Lake Erie at McKees Rocks, Pa., died suddenly on August 9. Mr. Lynn was born at Pittsburgh, Pa., August 2, 1869, and received his education in the public schools of that city. He entered the service of the Pittsburgh & Lake Erie in 1885 as a laborer, advancing as car repairman, car inspector, shop inspector and gang foreman until September 1, 1893, when he became foreman of pas-

Samuel Lynn

senger cars at the Pittsburgh terminal. He was promoted to the position of master car builder September 1, 1908, with offices at McKees Rocks, remaining in that position until February 1, 1927, when he was appointed superintendent of rolling stock. Mr. Lynn was for many years active on committees of the Master Car Builders' Association and its successor, the Mechanical Division of the A. A. R. He had been chairman of the Committee on Loading Rules since 1928. It has always been difficult to make a satisfactory report for this committee on the floor of the convention because of its great detail. Mr. Lynn, however, was unusually successful in making an intelligent, clean-cut presentation.

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"Oh Little Box Car Don't You Cry You'll be a freight house bye and bye!"

This little ditty originated years ago when a 40-ton freight car was "big." Today there are 120-ton capacity cars in regular service. Freight train length and locomotive capacity have increased at even a faster pace. » » » With this progress has come corresponding need for materials to withstand the constantly increasing severity of locomotive service. » » » Republic metallurgists anticipated this need and have developed special alloy irons and steels that are improving locomotive performance and lowering maintenance costs. » » » When axles, rods and pins encounter high stresses there are Agathon Alloy Steels of greater strength and fatigue-resistance to meet the new demands. Agathon Alloy staybolts are increasing the mileage per staybolt renewal for progressive railroads. For case hardened parts Agathon Nickel Iron provides surface hardness for wear and a tougher core which means fewer breakages. Special Alloy sheets reduce maintenance of large fireboxes. These are but a few of the many special railroad materials with which Republic is helping the railroads meet the new operating conditions. » » » May we send you further information? Address Department RG. » » »

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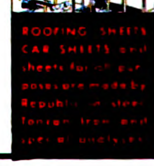
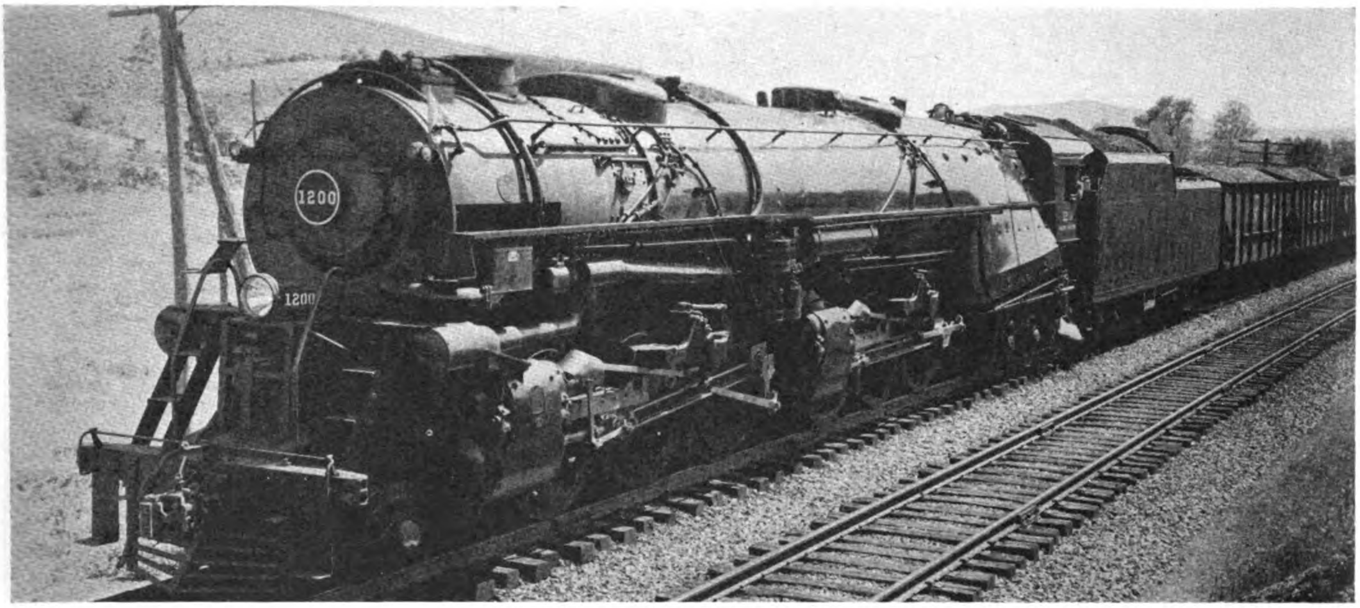


Large Boiler and Roller Bearings Feature

N. & W. LOCOMOTIVES



Simple articulated 2-6-6-4 type having 70-inch drivers develops 104,500 lb. tractive force. The total weight is 948,600 lb. and the overall length 120 ft. 7½ in.

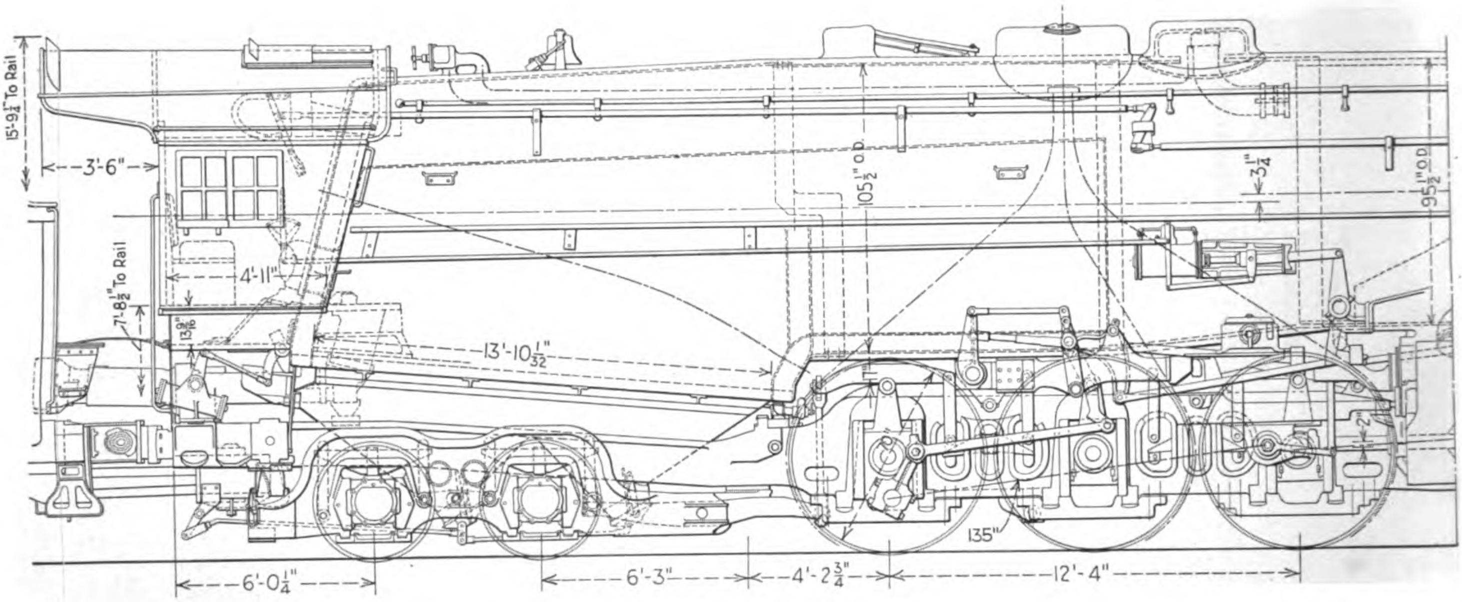
DURING May and June of this year the Norfolk & Western turned out of its Roanoke, Va., shops two simple articulated locomotives having roller bearings installed on all engine and tender wheels and the largest boilers which have as yet been built for any N. & W. locomotive. These locomotives have been built for fast freight service where speeds of 60 to 65 m. p. h. are required and tests which have been made indicate the ability of this power to perform satisfactorily. Road tests show that these locomotives can handle 4,800-ton trains on a 0.5 per cent grade at 25 m. p. h. without difficulty and that on comparatively level tangent track a speed of 64 m. p. h. has been attained with a 7,500-ton train.

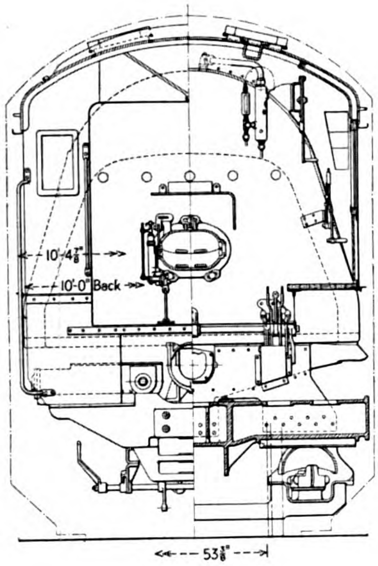
Accompanying this article is a chart showing the drawbar pull and drawbar horsepower plotted from dynamometer tests made with one of these locomotives while handling a merchandise train where the tonnage was relatively low and the speed high. The curve showing the drawbar horsepower (which is on level track) shows that the locomotive develops over 6,000 horsepower at speeds from 32 to 57 m. p. h., with a maximum of 6,300 hp. at 45 m. p. h.

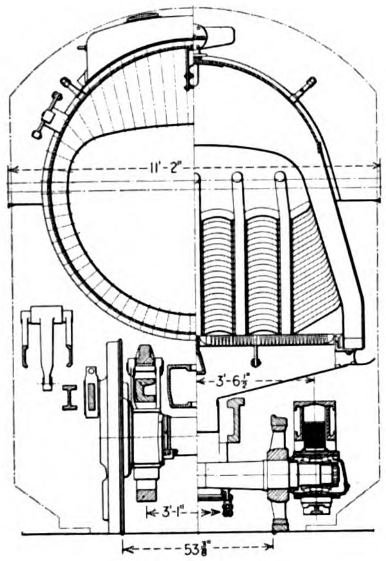
The Boiler

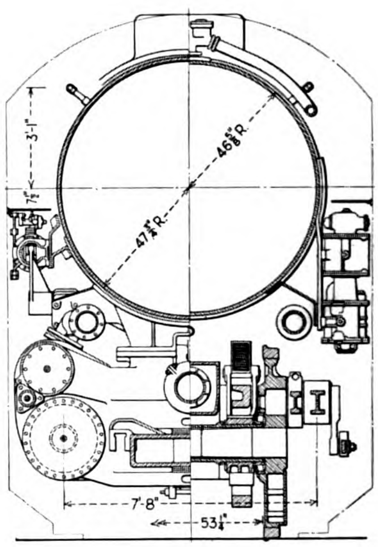
The boilers are of particular interest because of their size. With an overall length of 60 ft. 9³⁄₁₆ in. and a light weight of 148,500 lb. they are the longest and heaviest boilers that have been built to date for any N. & W. locomotives. The barrels are constructed in four courses ranging in diameter from 91 in. inside diameter at the first course to 105½ in. outside diameter at the fourth course. The two front courses have 1⅛-in. thick carbon steel sheets and the third and fourth courses have 1-in. and ¾-in. sheets of nickel steel. The roof sheet is ¾-in. nickel steel.

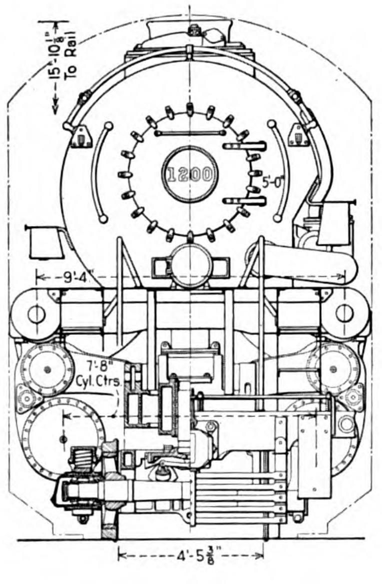
The firebox is electrically welded throughout. The grate has a length of 13 ft. 10 in. and a width of 8 ft. 10¼ in. with a grate area of 122 sq. ft. The combustion chamber is 9 ft. 8 in. long. The boiler has 239 3½-in. diameter superheater flues and 57 2¼-in. diameter tubes. The length of the flues is 24 ft. 1 in. The construction of each boiler involved 2,970 rivets and 4,925 staybolts. The boiler holds 8,100 gallons of water at the working height and 9,835 gallons when full. An interesting fact in connection with the boiler is that it expands in length 1⁵⁄₁₆ in. from cold to 330 lb. test pressure.





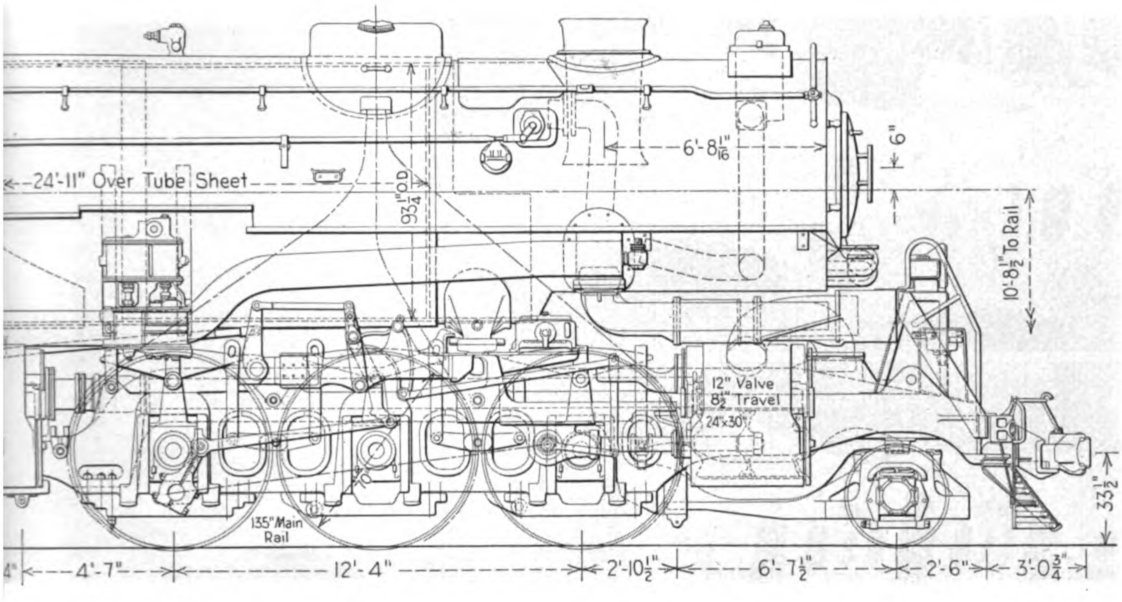






Above (left and center) cross sections at firebox and combustion chamber and back head

Above (right), section through driver and at rear engine cylinders and (below at the left) a front end view



Side elevations of the new Norfolk & Western locomotive

The boilers are designed for a working pressure of 300 lb. per sq. in., but are set to work at 275 lb. The grates used are of the N. & W. standard design and coal is fed by a Standard Type MB stoker. The firebox is equipped with a Security brick arch having five 3½-in. arch tubes.

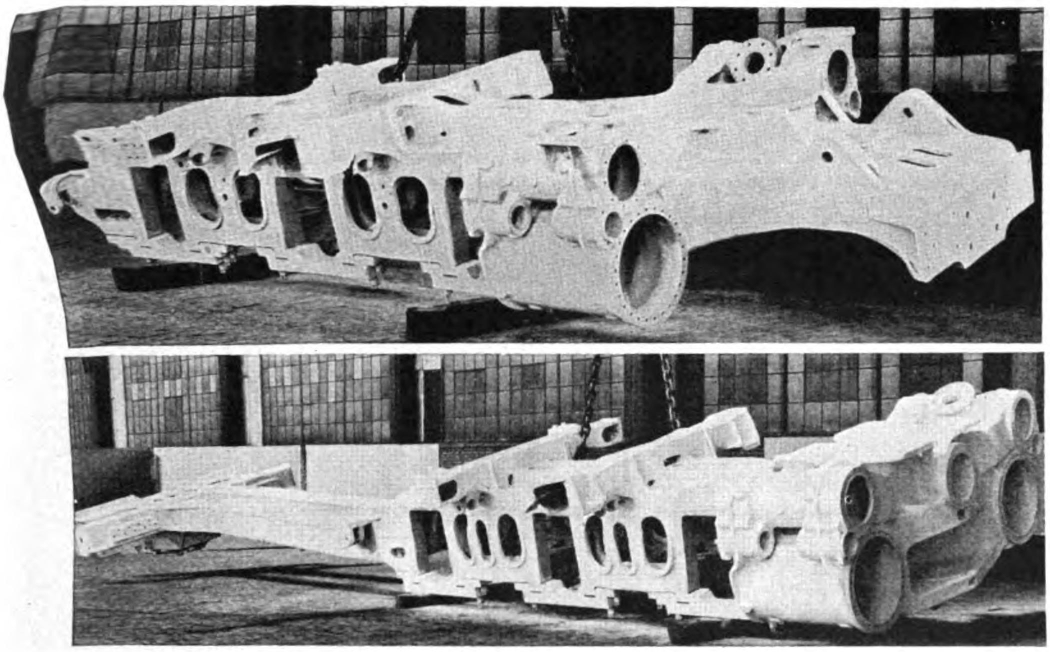
The boiler is fitted with an Elesco Type E superheater, with an American multiple throttle and a Worthington Type 6-s-A feedwater heater having a rated capacity of 12,000 gallons per hour. A Nathan live-steam injector of the horizontal non-lift type with a rated capacity of 10,000 gallons is used. The safety valve equipment consists of four Ashton 3½-in. Type FC-10 valves.

These locomotives are of the single-expansion articulated type and have four cylinders, cast integral with the frames, 24 in. in diameter by 30 in. stroke. With

General Dimensions, Weights and Proportions of the N. & W. 2-6-6-4 Type Locomotive

Railroad	Norfolk & Western
Builder	Railroad company
Type of locomotive	2-6-6-4
Road Class	"A"
Road numbers	1200 and 1201
Date built	May and June, 1936
Service	Fast freight
Dimensions:	
Height to center of boiler, ft. and in.	10—5¼
Height to top of stack, ft. and in.	16—0
Width overall, in.	134
Cylinder centers, in.	92
Weights in working order, lb.:	
On drivers	430,100
On front truck	30,300
On trailing truck	109,600
Total engine	570,000
Tender	378,600
Wheel bases, ft. and in.:	
Driving	35—5
Rigid	12—4
Engine, total	60—4¾
Engine and tender, total	108—7¼
Trailing	5—0
Wheels, diameter outside tires, in.:	
Driving	70
Front truck	36
Trailing truck	42
Engine:	
Cylinders, number, diameter and stroke, in.	4—24 x 30
Valve gear, type	Baker
Valves, piston type, size, in.	12
Maximum travel, in.	8½
Steam lap, in.	2
Exhaust clearance, in.	1/16
Lead, in.	¼
Cut-off in full gear, per cent	75
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	275
Diameter, first ring, inside, in.	91
Diameter, largest, outside, in.	105½
Grate, length, in.	166 1/32
Grate, width, in.	106¼
Height mud ring to crown sheet, back, in.	70¼
Height mud ring to crown sheet, front, in.	93¾
Combustion chamber length, ft. and in.	9—8
Arch tubes, number and diameter, in.	5—3½
Tubes, number and diameter, in.	57—2¼
Flues, number and diameter, in.	239—3½
Length over tube sheets, ft. and in.	24—1
Net gas area through tubes and flues, sq. ft.	11.24
Fuel	Bituminous
Stoker	Standard Mod. Type "B"
Grate type	N. & W. Std.
Grate area, sq. ft.	122
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	530
Arch tubes	57
Firebox, total	587
Tubes and flues	6,063
Evaporative, total	6,650
Superheating (Type E)	2,703
Combined evap. and superheat	9,353
Feedwater heater, type	Worthington 6-S-A
Live steam injector	Nathan
Tender:	
Style or type	Rectangular
Water capacity, U. S. gal.	22,000
Fuel capacity, tons	26
Trucks	Six-wheel
General data, estimated:	
Rated tractive force, engine, 75 per cent cut-off, lb.	104,500
Speed at 1,000 ft. per min. piston speed, m.p.h.	41.6
Piston speed at 10 m.p.h., ft. per min.	240.1
R.p.m. at 10 m.p.h.	48
Weight proportions:	
Weight on drivers ÷ weight, engine, per cent	75.5
Weight on drivers ÷ tractive force	4.12
Weight of engine ÷ comb. heat. surface	61.0
Firebox heat. surface, per cent comb. heat. surface	6.28
Tube-flue heat. surface, per cent comb. heat. surface	64.9
Superheat. surface per cent comb. heat. surface	28.9
Firebox heat. surface ÷ grate area	4.8
Tube-flue heat. surface ÷ grate area	49.7
Superheat. surface ÷ grate area	22.2
Comb. heat. surface ÷ grate area	76.7
Gas area, tubes-flues ÷ grate area	.0921
Tractive force ÷ grate area	857.0
Tractive force ÷ comb. heat. surface	11.2
Tractive force × dia. drivers ÷ comb. heat. surface	782.1

275 lb. boiler pressure and 70-in. driving wheels they have a rated tractive force of 104,500 lb. The cylinders are spaced 92 in. on centers and have 12-in. piston valves with a maximum travel of 8½ in. The steam lap is 2 in., the exhaust clearance is 1/16 in. and the lead ¼ in. The maximum cutoff is 75 per cent. The valves are operated by Baker valve gear which is controlled

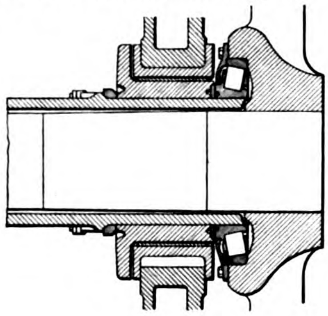


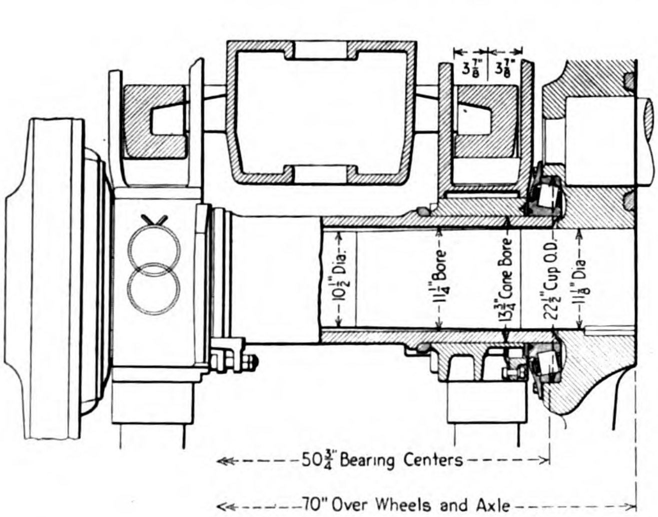
The front (top) and rear (bottom) units of the cast steel beds embodying the frames, cylinders and cross members. The two castings have a total weight of 110,925 lb. and their use displaced over 700 parts

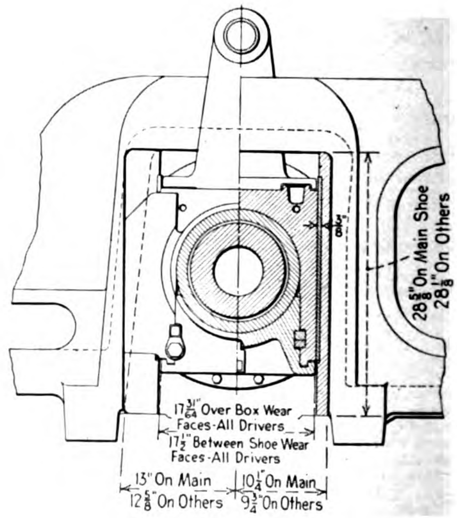
by an Alco Type H reverse gear. The crossheads and guides are of the multiple-bearing type. The axles, crank pins and rods are of open-hearth carbon-steel forgings, normalized.

Roller Bearings

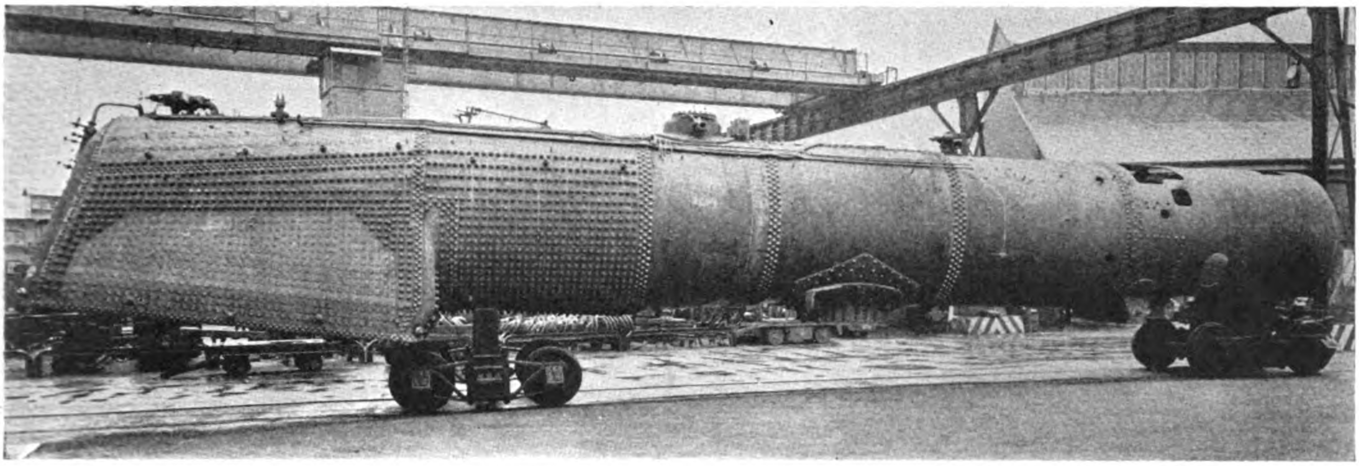
All of the wheels of both engines are equipped with Timken roller bearings. The tender of one engine has Timken roller bearings; the other has A.S.F. roller-bearing units. The driving-wheel installation is of special interest because it is the first of its kind. The driving-wheel assembly consists primarily of the wheels and axles, the axle tube or sleeve, the roller bearings and the driving boxes. The roller bearings are recessed into the driving-wheel hubs and the driving axles carry none of the locomotive weight, the weight being carried by the tubes. The outer races of the roller bearings are fitted into a recess in each driving-wheel hub and the inner races are pressed onto the ends of a finished axle sleeve, or tube. The axle tube is supported in the driving boxes. The axles are hollow bored and in assembling the wheels and bearings the axle is pressed into one driving wheel. The tube, with the roller bearings slipped on each end, is placed over the axle. The other driving wheel is then pressed onto the axle, after which the outer races of the bearings are placed in the recesses in the wheel hubs. The inner races of the bearings are then pulled to the ends of the sleeves inside the recesses in the wheel hubs where the rollers are made to contact the outer races. The as-



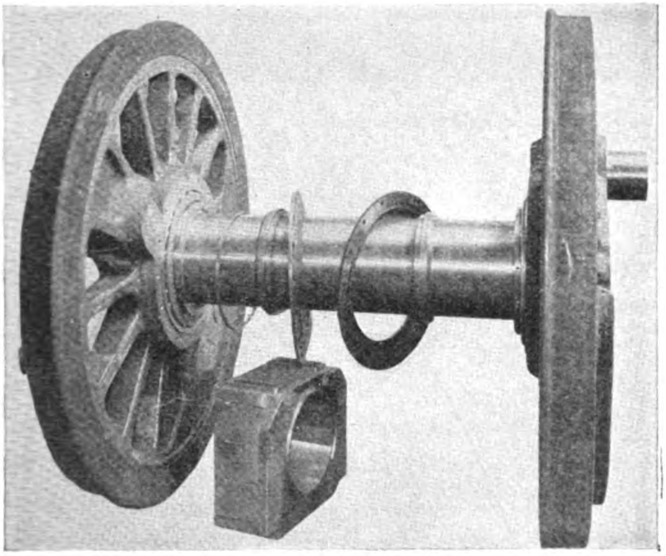




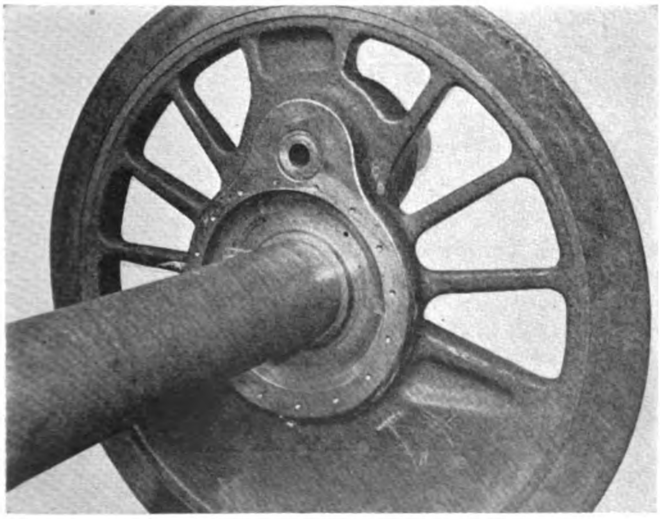
Drawing of the driving wheel roller bearing installation. At the left a cross section and plan section showing driving box and shoe and wedge and, at the right an end view and section at one pedestal showing lock key arrangement



Largest boiler ever built for a Norfolk & Western locomotive



A driving wheel assembly with the bearings in place in the wheel hubs and the enclosure plates shown on the axle tube

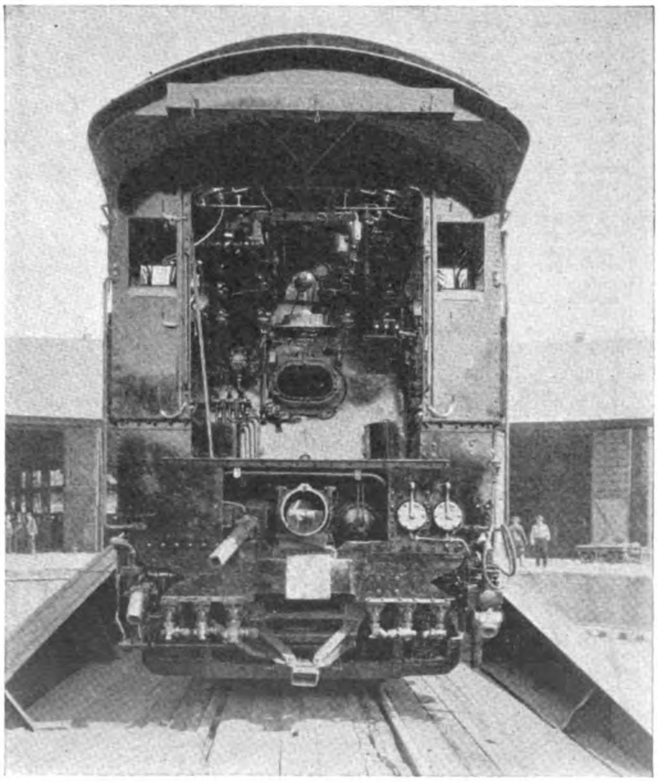


Wheel hub, showing the recess for the bearing race

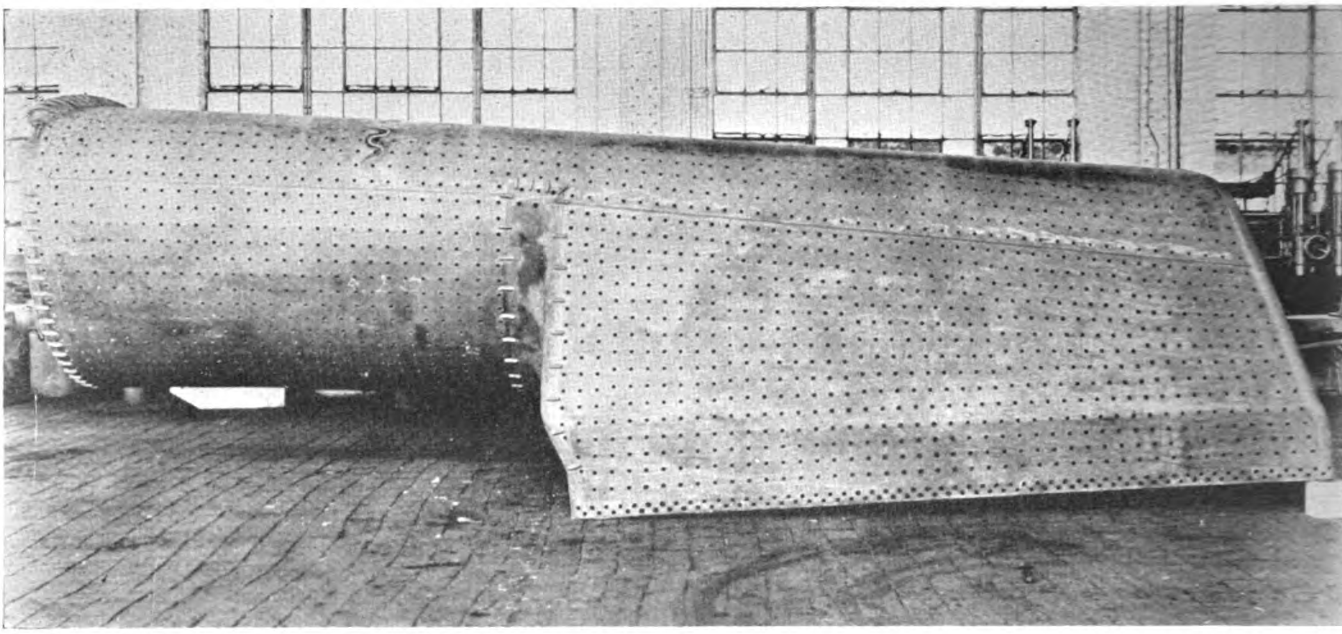
sembly is completed by bolting the enclosure plates to the wheel hubs and clamping the driving boxes to the axle hub. This is accomplished by two pairs of wedges in the joints between the top and bottom sections of the driving box. The driving boxes are held in position on the tube by a backing ring on the inside end of each box and a three-piece adjusting spacer between the box and the inner bearing race. The driving boxes move vertically in the frame jaws between hardened bronze liners. The frame wedge is welded to the frame. The roller bearings are lubricated by grease which is forced into the bearing through fittings in the wheel hubs. The driving axles are of Timken design.

The roller bearings on the engine and trailer trucks are conventional Timken installations. The tender of one locomotive is mounted on Buckeye six-wheel trucks with Timken roller bearings, and the other tender has Commonwealth six-wheel trucks with A.S.F. roller-bearing assemblies.

The engine frames, cylinders and frame cross members are all cast integral in two bed castings weighing 110,925 lb. which were furnished by the General Steel Castings Corporation. By the use of these cast-steel frames it is estimated that 66 major parts and 634 minor parts were displaced. The two-wheel engine truck and



The cab and back head



The firebox and combustion chamber were electrically welded throughout

the four-wheel trailer truck frame castings were also furnished by the General Steel Castings Corporation.

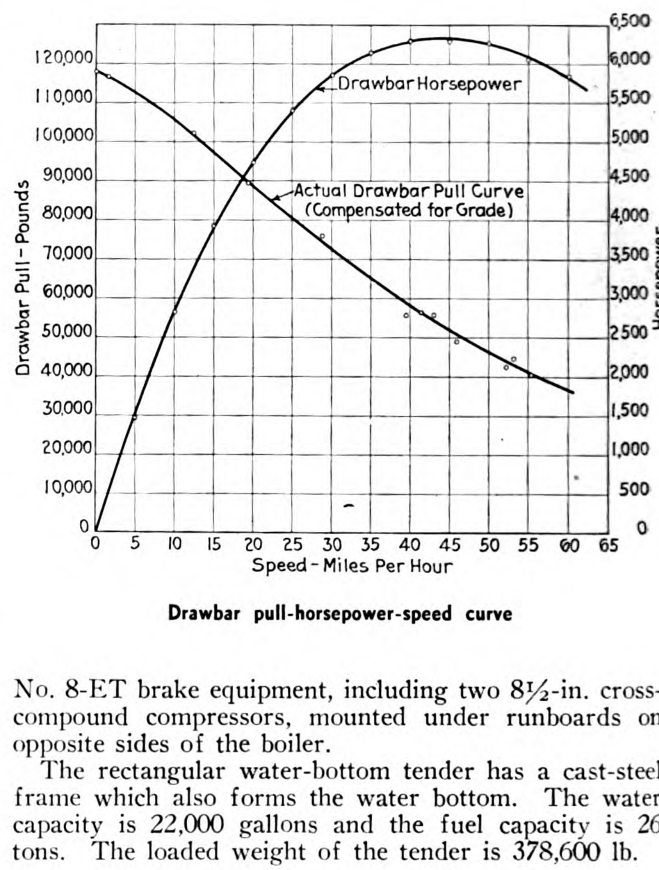
High-pressure grease-gun fittings are used in numerous locations and two Nathan mechanical lubricators, actuated by the combination lever, supply oil from 33 leads to 72 outlets for the lubrication of the cylinders, steam chests, guides, steam-pipe slip joints, pedestal shoes and other surfaces.

The locomotives are equipped with Westinghouse No. 8-ET brake equipment, including two 8½-in. cross-compound compressors, mounted under runboards on opposite sides of the boiler.

The rectangular water-bottom tender has a cast-steel frame which also forms the water bottom. The water capacity is 22,000 gallons and the fuel capacity is 26 tons. The loaded weight of the tender is 378,600 lb.

Special Equipment Applied on N. & W. 2-6-6-4 Type Locomotives

Boiler:	
Boiler steel, nickel, third and fourth course and roof	Bethlehem Steel Co.
Boiler steel, carbon, first and second course, and outside side sheets	Lukens Steel Co.
Firebox steel, firebox and comb. chamber	Lukens Steel Co.
Brick arch (Security)	American Arch Co.
Superheater (Type E)	Superheater Co.
Throttle valve, multiple	American Throttle Co.
Feedwater heater (Type 6-S-A), 12,000 g.p.h.	Worthington Pump & Machinery Corp.
Injector, live steam, 10,000 gal. cap.	Nathan Manufacturing Co.
Stoker (Mod. Type B)	Standard Stoker Co.
Firedoor (No. 9)	Franklin Railway Supply Co.
Cab Fittings and Boiler Mountings:	
Safety valves (Type FC-10), 4—3½ in.	Ashton Valve Co.
Water column	Nathan Manufacturing Co.
Bell ringer	Viloco Railway Equipment Co.
Sanders	Graham-White Sander Corp.
Reducing valve, steam heat (Type AL)	Leslie Co.
Headlight generator (Type E-3)	Pyle-National Co.
Headlight case, cast aluminum	Pyle-National Co.
Cylinders and Driving Gear:	
Valve gear	Pilliod Company
Packing, piston rod and valve stem	Paxton-Mitchell Co.
Cylinder cocks	Okadee Manufacturing Co.
Reverse gear (type H)	American Locomotive Co.
Frames and Running Gear:	
Frames, cast steel	General Steel Castings Corp.
Roller bearings, all engine and tender wheels	Timken Roller Bearing Co.
Roller bearings, tenders	Timken Roller Bearing Co. (1) American Steel Foundries (1)
Lubrication:	
Lubricators, mechanical	Nathan Manufacturing Co.
Brakes:	
Air brake (Schedule 8ET)	Westinghouse Air Brake Co.
Air compressors, 2—8½-in. cross-compound	Westinghouse Air Brake Co.
Driver brakes	American Brake Co.
Draft gear, tender (Type B-32-K)	Edgewater Steel Co.
Tender:	
Frame, water bottom	General Steel Castings Corp.
Buffer, radial (Type E)	Franklin Railway Supply Co.
Flexible connections	Franklin Railway Supply Co.
Trucks, six-wheel	Eng. 1200 "Commonwealth," General Steel Castings Corp. Engine 1201—Buckeye Steel Castings Co.



Drawbar pull-horsepower-speed curve

Joy Ride—A locomotive and six empty passenger cars were sent upon a brief, wild run in Baltimore, Md., recently, by a man who suddenly boarded the engine, slugged the engineman and jerked the throttle wide open. The heavy locomotive and the six cars ran off the end of the track at the Hillen station of the Western Maryland, plunged through a gate and plowed into a shed at the rear of the station. As the roof of the shed tumbled down about the locomotive, railroad employees rushed to the cabin to catch the man. It took eight men to subdue him. Later, 10 officers were required to quiet him at a police station. The identity of the man was not determined.

Link Motion Valve Gear

Part II

By J. Edgar Smith

Laying out the gear — Effects of combination lever and link — Location of parts

BEFORE starting the actual layout of the Walschaert gear, it is well to calculate the lengths and proportions of such members as can be readily calculated. In order to do this it is necessary to continue considering the functions of the combination lever and the link separately. Fig. 7 shows the effect of the combination lever alone while Fig. 8 shows the effect of the link alone.

In Fig. 7, it will be noted that dimensions x, y and z must be taken from the general plan of the locomotive

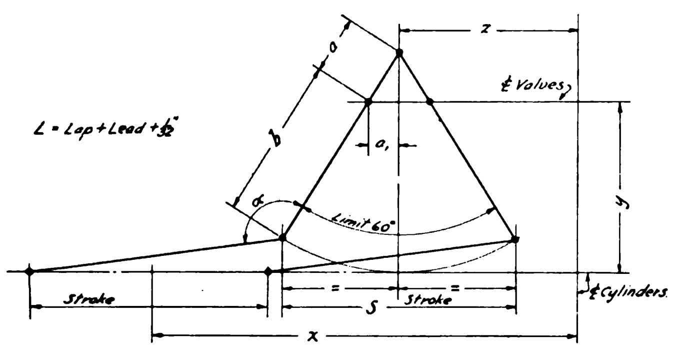


Fig. 7

under consideration. The extreme positions of the combination lever due to the motion of the crosshead should not exceed 60 deg., in order that the angle α be kept well within its limit of 135 deg.

In Fig. 8, it will be noted that angle θ is taken at 40 deg., which is less than the recommended limit, in

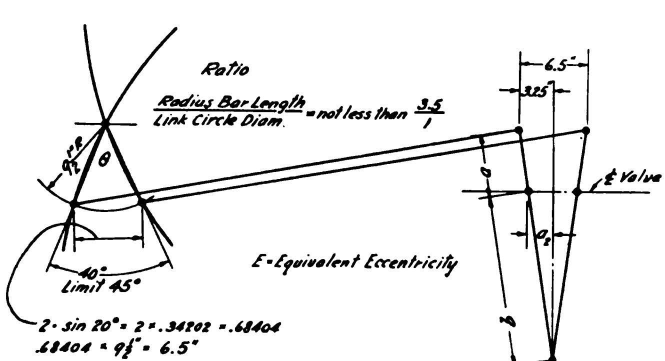


Fig. 8

order that the throw of the eccentric will not be excessive nor difficulty be encountered in holding the angle between the eccentric rod and the link tail within the limit of 135 deg. The radius of the link circle is taken at 9½ in. in order that full advantage may be taken of the motion of the link in proportioning the reversing mechanism. However, should the ratio of the radius rod length to the link circle diameter be less than 3.5 to 1, it would be necessary to reduce the link circle diameter.

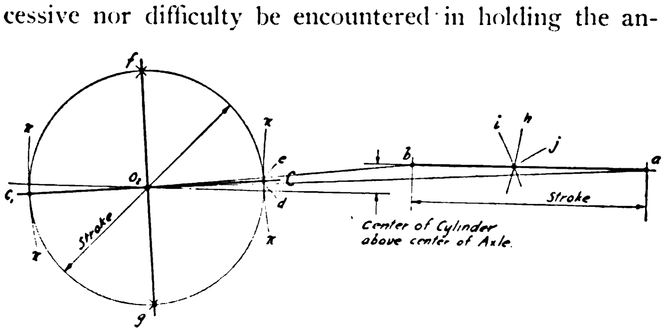


Fig. 9

Derivation of the Formula for Combination Lever Proportions

From Fig. 7:—

$$a : a + b = a_1 : .5\ S$$

or

$$a_1 = .5S\left(\frac{a}{a+b}\right)$$

since a_1 = lap + lead or L, this value should include $\frac{1}{32}$ in. for lost motion in the pin connections.

From Fig. 8:—

$$b : a + b = a_2 : 3.25$$

or

$$a_2 = 3.25\left(\frac{b}{a+b}\right)$$

a_2 = equivalent eccentricity or E

then

$$L : E = .5S\left(\frac{a}{a+b}\right) : 3.25\left(\frac{b}{a+b}\right)$$

therefore

$$\frac{.5SEa}{a+b} = \frac{3.25Lb}{a+b}$$

$$.5\ SEa = 3.25\ Lb$$

$$a = \frac{3.25\ L}{.5\ SE} \times b$$

or

$$a = \frac{6.5\ L}{SE} \times b \text{ for } 9\tfrac{1}{2}\text{-in. link circle radius.}$$

Should it be necessary to select a shorter link circle radius, the following formulae may be used to correspond to the various radii:

Link circle radius	Formula
9 in.	$a = \frac{6.16\ L}{SE} \times b$
8½ in.	$a = \frac{5.82\ L}{SE} \times b$
8 in.	$a = \frac{5.47\ L}{SE} \times b$
7½ in.	$a = \frac{5.13\ L}{SE} \times b$
7 in.	$a = \frac{4.78\ L}{SE} \times b$

Link circle radius	Formula
6½ in.	$a = \frac{4.45\ L}{SE} \times b$
6 in.	$a = \frac{4.11\ L}{SE} \times b$

The upper arm of the combination lever should not be less than 2½ in. If possible, attach the union link directly to the crosshead pin as shown in Fig. 7. With the combination lever dimensions determined, the layout may be started, laying out at not less than 3 in. to 1 ft. scale, and starting with all the basic centerlines taken from the general plan.

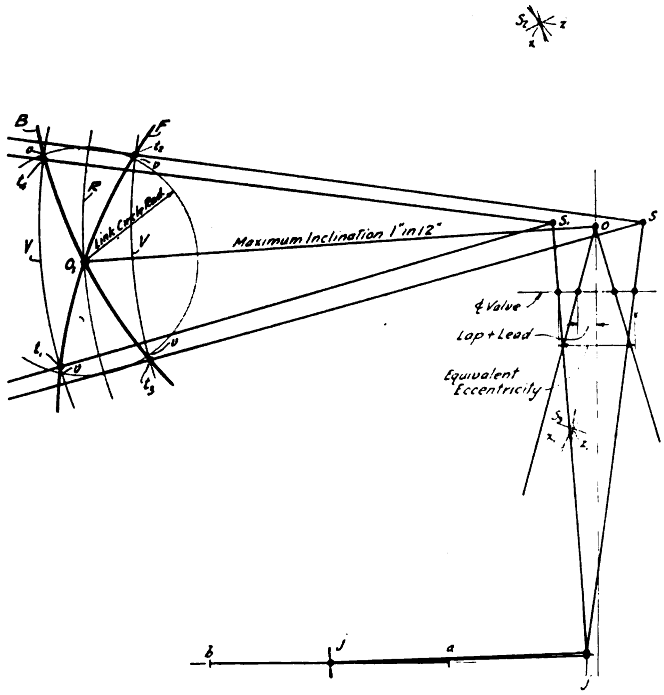


Fig. 10

With a and b as centers and the length of the main rod as a radius, describe arcs π-π as indicated in Fig. 9. Connect O_2 with a and b, intersecting stroke circle at e and d. Midway between e and d locate C, which is the forward dead-center position of the crank pin. From C, through O_2, draw a line intersecting the stroke circle at C_1, which is the back dead-center position. Points f and g are located midway between C and C_1. Then with f and g as centers and the length of the main rod as a radius, describe arcs h and i, locating point j on the crosshead path. When the point of intersection of arcs h and i is off the center of the cylinder, it indicates that, for the length of main rod selected, the height of the center of the cylinder above the axle center is not correct. This should be corrected, if conditions permit, before continuing with the design.

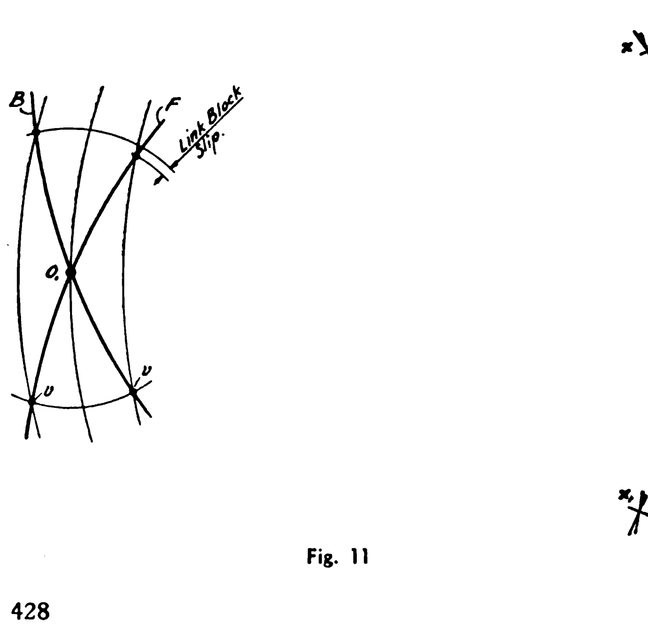


Fig. 11

Locating Link Positions

By locating the bottom connection of the combination lever in Fig. 10, from position j as found in Fig. 9, and the valve stem locations according to the equivalent eccentricity, positions s and s_1 can be established.

From O describe arc R with the length of the radius bar OR as a radius; also from S and S_1 describe arcs V cutting the link circle at points v. From points O_1 and v describe arcs at S_2 and S_3. Join O_1Z and O_1Z_1 to locate points x and x_1. With the same radius OR, describe from x and x_1 arcs F and B, which intersect arcs V at t_1,t_2,t_3 and t_4, the actual positions of the link block at extreme link throw. This method divides up the link-block slip between forward and backward motion.

In the case of passenger locomotives it is sometimes desired to throw all the link-block slip into the back-up motion. Then, as in Fig. 11, with O_1 and v-v (in full gear forward) as centers, locate points x and x_1 as centers of the link radius. F and B will then represent the positions of the link in extreme positions.

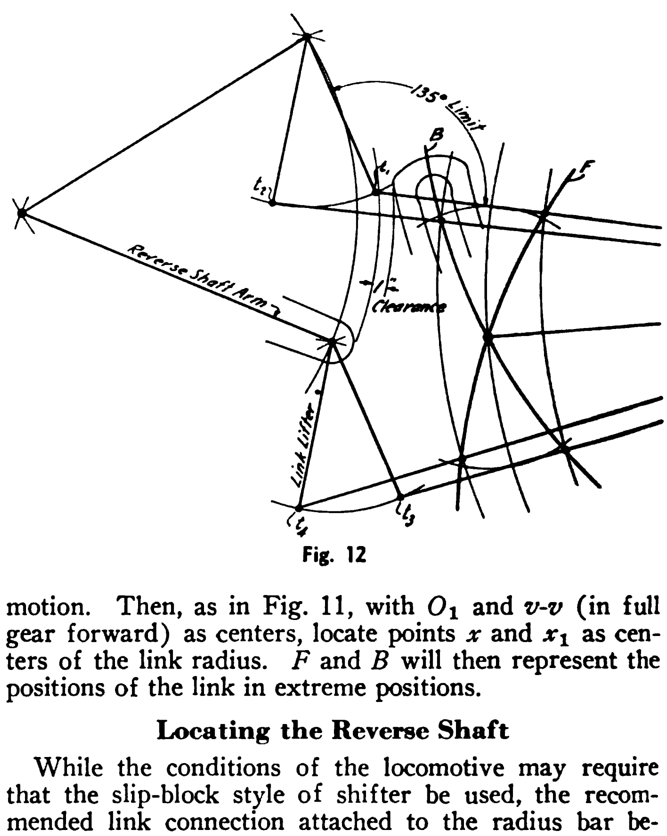


Fig. 12

Locating the Reverse Shaft

While the conditions of the locomotive may require that the slip-block style of shifter be used, the recommended link connection attached to the radius bar beyond the link block will be described here.

By assuming a length Ft_1 and locating points t_2, t_3 and t_4, as shown in Fig. 12, the center of the reverse shaft can be located. Care should be taken that the angle between the link lifter link and the radius rod does not exceed 135 deg. in extreme positions, and that the reverse shaft arm clears the link in its extreme position by at least 1 in.

Locating the Eccentric Crank and Eccentric Rod

With the crank pin positions C, C_1, f and g as in Fig. 9, and the link positions R, F and B as in Figs. 10 or 11, assume, tentatively, a link tail radius L and offset T

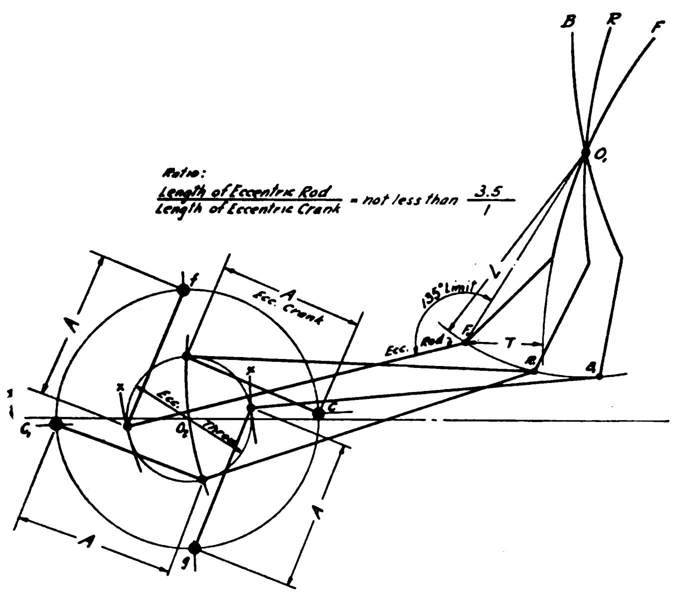


Fig. 13

which will locate points R_1, F_1 and B_1. With R_1O_2 as a radius, describe arcs x-x as shown in Fig. 13. If the link tail offset T is correct, arcs x-x will be equidistant from O_2 so that an eccentric throw circle may be drawn with O_2 as a center. Then if, with F_1 and B_1 as centers and R_1O_2 as a radius, the eccentric throw circle will be intersected at points which are the same distance A from C and C_1, then the elements shown are correct. It will be noted that it is usually necessary to make several trial layouts, assuming different values of L, T, and R_1O_2, before eccentric crank A will check out in all four positions.

Care should be taken to see that the angle between the link tail and the eccentric rod in the extreme position does not exceed 135 deg. Also, the ratio of the length of the eccentric rod to the length of the eccentric crank should not be less than 3.5 to 1.

By laying out the valve gear as described, very little adjustment in the shop will be necessary. All the elements have been laid out with particular reference to their independent functions and if it is desired to plot the gear layout in several positions of the stroke, the total valve travel, valve events and valve positions with respect to the crosshead positions, will be found to hold very accurately to the values determined in advance by means of the Zeuner diagram and the theoretical valve ellipse. For this reason, it is seldom necessary to entail the extra work of actually plotting the ellipse from the layout or even setting up the gear on a model in order to take the valve events and the valve ellipse readings.

(To be continued)

Failures of

Locomotive Parts*

By F. H. Williams†

Locomotive tires fail because of defects in the steel chargeable to the manufacturer, as well as because of rough machine work in the railroad shops. The latter type of defect was considered in the *Railway Mechanical Engineer* for July, page 314. The present article will deal with manufacturers' defects.

It is comparatively easy to distinguish between a failure caused by a defect in the steel and one caused by rough machining. It is not alway an easy matter, however, to convince the one who is at fault that he is responsible. With rough boring and evidence of a fatigue crack starting from the bore, it is, of course, useless to attempt to prove that the manufacturer is to blame. There may be a manufacturer's defect in the same place that the fatigue crack started, but it is usually so insignificant in appearance compared with the rough machine work that the cause of the failure must be ascribed to the latter.

It is necessary, when a broken tire is to be examined by the metallurgist, that all of the fractured ends be sent to the laboratory, so that he can have a clear picture of what happened. Ordinarily a critical examination of all of the breaks will reveal the location of the first one. While the other breaks will, of course, be examined and reported upon, the primary break will receive the greater amount of attention and naturally will carry the onus of the failure.

* Part 4 of an article which began in the May issue.
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Break Caused by Defective Material

In the first example which will be considered in this article, only one of the six pieces into which the tire broke was at first shipped in. Had the cause of the break been based on this one piece, the failure would have been charged to rough boring. After a careful examination of the single part there was some question as to whether the particular fracture was the primary break. The other parts of the tire were sent for and an examination of the 12 ends revealed the part that was the first to fail. A detailed progressive examination was then made of the two surfaces of the fracture and the report was based on this break.

A fracture from a defect in the steel will usually be indicated within the broken section of the tire, while a fracture from rough machine work will start from the surface. This particular tire failed from a defect in the steel, which appeared in the fracture as a straight crack 1½ in. in width, parallel with the tread, and starting ⅝ in. from the outer face of the tire. This crack is shown in Fig. 1; the dark area directly above the crack is the shadow of the overhanging fracture and has no particular significance.

Examination of the fracture revealed a narrow band about ⅛ in. deep under the crack. This is part of the fatigue crack, transverse to the major portion. which is parallel to the surface of the tread, and the tire failed when the crack turned downwards and across the section. As long as it ran parallel to the tread, the tire

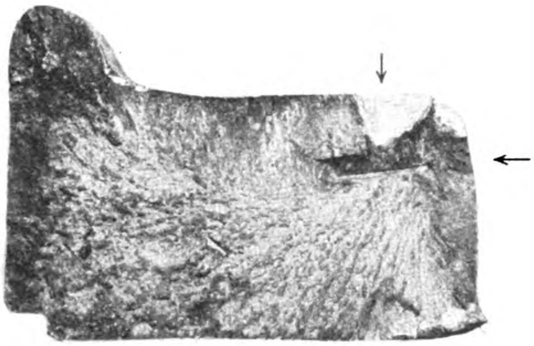

FIG. 1

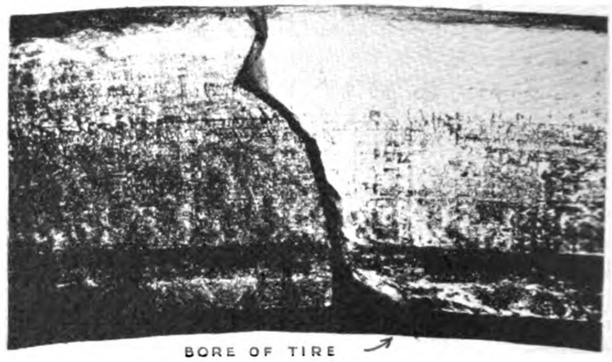

FIG. 5

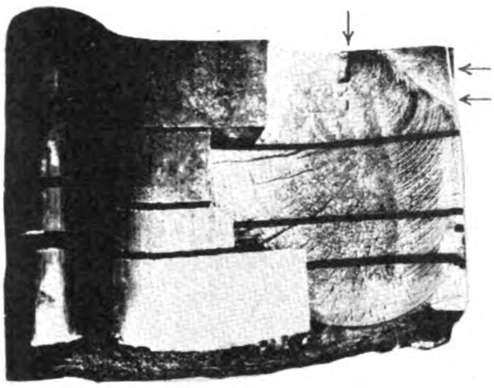

FIG. 2

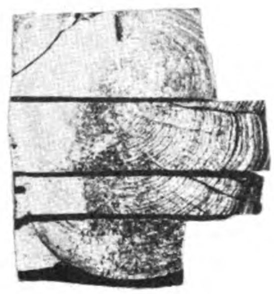

FIG. 3

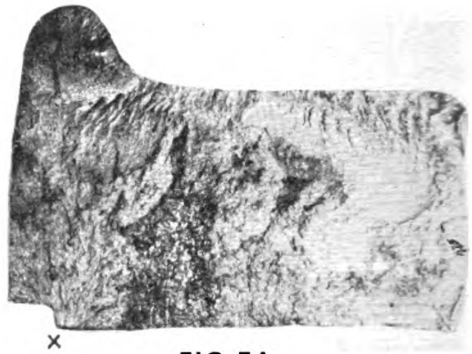

FIG. 5A

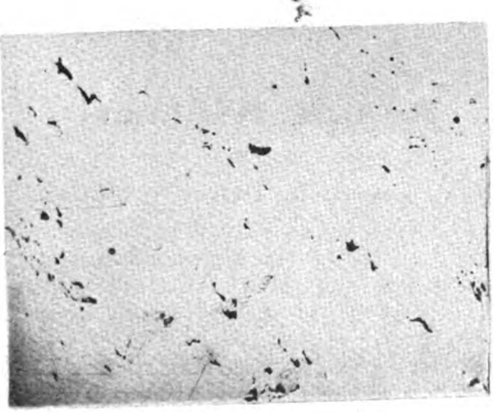

FIG. 4

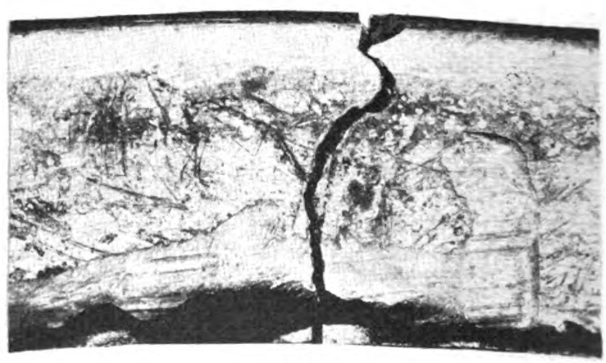

FIG. 7

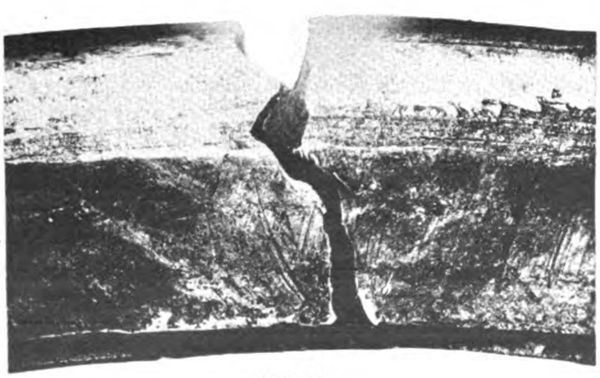

FIG. 6

FIG. 7A

remained intact, although the surface of the crack may have been several square inches in area; as a matter of fact, this actually proved to be the case when the fatigue crack was opened up to view.

Looking at the long crack in the fractured end of the tire, as shown in Fig. 1, the verdict in general was that the tire was piped and that it failed because of this. A pipe would hardly occur in such a location and in that shape, however, and it was decided to make a more detailed study of the fracture.

Several slots were cut through the tire parallel to the fracture, the sections varying in width from ½ in. to an inch. These were then cut crosswise as shown in Fig. 2, so that the pieces could be removed and the crack opened up to view. The mate to this face is shown in Fig. 3. As each slice was cut and examined, the picture began to clear up and the pipe faded into a fatigue crack of unusual proportions; the cutting continued until the nucleus was disclosed and the cause clearly developed. The defect is indicated by the dark line near the top of the view in Fig. 2; this was about ¼ in. in length and a short distance below was a second defect shown by a dark spot about 1/16 in. long.

Macrostructure Examination

A section of the tire was then cut, polished and deep etched, with the result that a small area at the nucleus of the defect was eaten out by the acid. This area, more porous than the main part of the section, was in the deep etched part which appeared to be free of any defects. This small area was just in line with the flaw shown in Figs. 2 and 3 and is an indication of the source of the failure. Incidentally, this case is similar to a number of others where failures under the drop test were chargeable to such defects.

Microscopic Examination

Continuing the study, a specimen was cut for examination under the microscope; it included the area which showed up as defective in the deep etched section. This unetched specimen showed that the steel in the defective area was full of inclusions. A microphotograph is shown in Fig. 4. The defects appear to be sulphides and when the surface was deep etched they were eaten out, leaving the section porous. This flock of sulphides was about ¼ in. in length and 1/32 in. in width—a rather small defect in the steel, yet it was the cause of the failure of the tire.

Why Was It the Primary Break?

Why did we select this break as the primary cause of the failure? Examining the tire in general we found that it had been slightly warped and was not true. To remedy this the shops faced off a portion on one side, and rather roughly at that; about two-thirds of the surface on the flange side showed evidences of removal of material in this way.

The tire in question broke into six pieces and it was, of course, advisable, if possible, to study the break which opened up first. In our studies of tire failures over the past ten years or so we have had many instances where there was only a single break. When a tire fails in this way the fracture is usually practically in a straight line, starting from the bore and at right angles to a tangent to the circle at the point from which the break starts. In many instances the fracture forms a right angle with this tangent for the full thickness of the tire.

Simple examples of such breaks will be found in tires broken in the course of shipment. Recently I noticed a tire that failed, which was shrunk on the wheel center just before the shops closed down for the holidays. The men on returning to work after the holiday season discovered the tire broken. The fracture was perfectly straight across the section, starting from a torn sharp edge—otherwise the tire was perfect. Based on many instances of this kind, we have concluded that when a tire breaks into several pieces, generally speaking that fracture which is straightest across the full section of the tire is the primary break.

Let us now consider the other extreme—the case where the tire fails with an irregular break, although it started with a fracture that for an inch or two was similar to the lines of the primary break. In other words, the fracture starts out exactly like that of a primary break and then flares out on either one side or the other. One of the tests required before a shipment of tires leaves the mill is the drop test. It is not unusual for a tire to fail under such a test, in which case the breaks are similar to those just mentioned, whether the failure starts from tool marks caused by rough machining, or defects in the steel. The manufacturers are careful to protect the tires from failures by taking pains to remove all sharp edges by rounding them off, and by using fillets rather than making sharp corners.

The illustrations with this article attempt to show the difference between primary and secondary fractures and represent average failures of each type. It is not intended to convey the impression that all failures of either type will be similar. There are, of course, departures from the average and in such cases critical investigations must be made in the attempt to determine which is the primary fracture. Most of the failures, however, come fairly close to the typical types described above, the primary fracture being a straight break across the section and the secondary fractures starting off in a straight line for a short distance, and then flaring out.

With this background, let us examine the four fractures in the tire which are illustrated by Figs. 5, 6, 7, and 8. These are all views looking toward the flange side of the tire. All of the fractures except the one illustrated in Fig. 8, show the break deviating from a straight line, about one inch from the bore. It is, therefore, fair to assume that the break shown in Fig. 8 was the primary cause of failure. The others (Fig. 5, 6, and 7) are typical fractures for a tire failing under the drop test; that is, of a tire that has been crushed by pressure. We, of course, do not know the exact sequence of the secondary failures. They may have been the result of blows only, or a combination of blows with defects in the steel or rough machine work. In this particular case we decided that they were mostly the result of blows and rough machining, the latter being started small fatigue cracks, which in time would have resulted in a complete fracture.

Fig. 1—Primary fracture, showing crack parallel to tread. Fig. 2—Tread of tire cut away to show the face of the transverse fatigue crack. The two dark spots in the upper right-hand corner, and in line with the arrows, are defects which caused the failure; in other words, they are the nuclei of the fatigue crack. Fig. 3—The opposite face of the fatigue crack shown in Fig. 2. Fig. 4—A micro-photograph showing defects which caused the failure. Fig. 5—Side view of tire, which was faced off because of warping. This is one of the secondary fractures. Fig. 5a—Cross section of break shown in Fig. 5. Note the fatigue crack at X. Fig. 6—Another side view of the tire, showing rough facing. This is another secondary fracture. Fig. 7—Another side view of the tire. No metal was removed at this point in the facing process. This is another secondary fracture, the break starting at the bore, as in Figs. 5 and 6. Fig. 7a—Cross section of the break shown in Fig. 7. The fatigue crack started at X, at the edge of the counterbore.

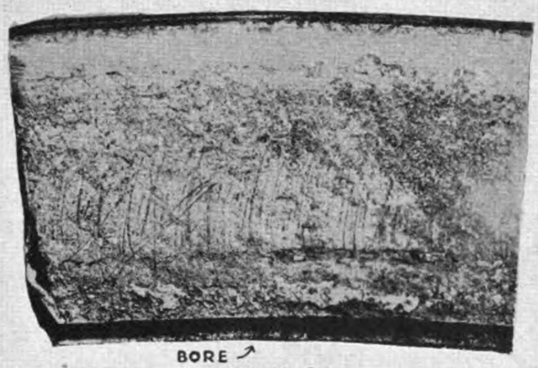

FIG. 8

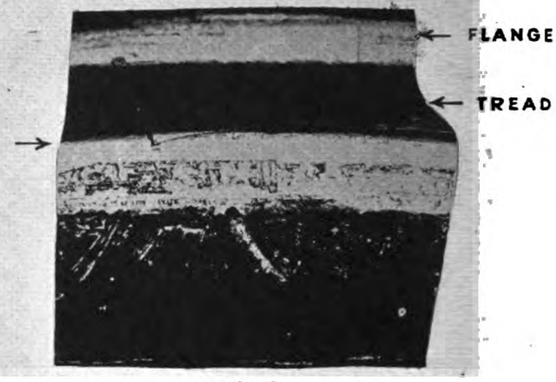

FIG. 9

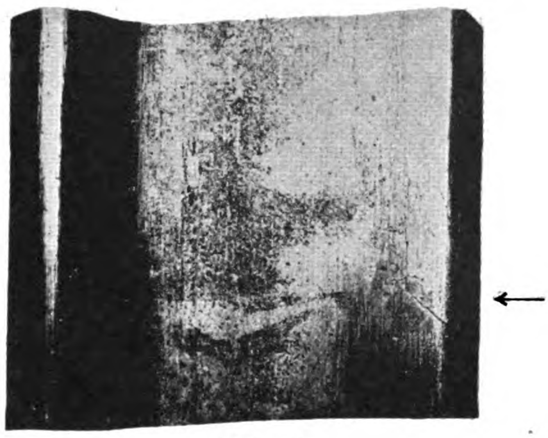

FIG. 10

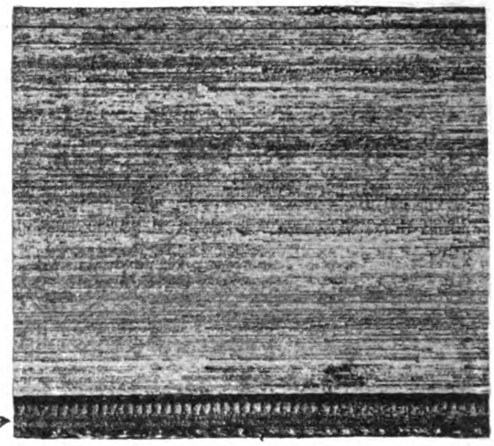

FIG. 11

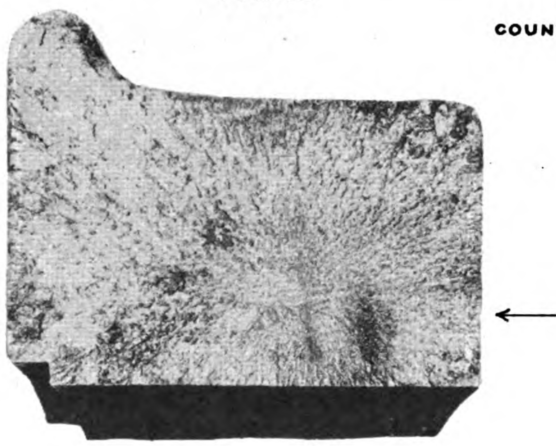

FIG. 12

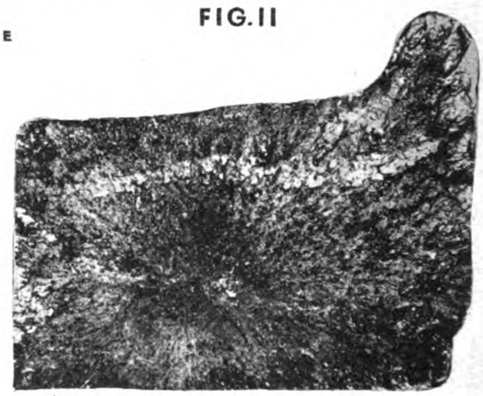

FIG. 12 A

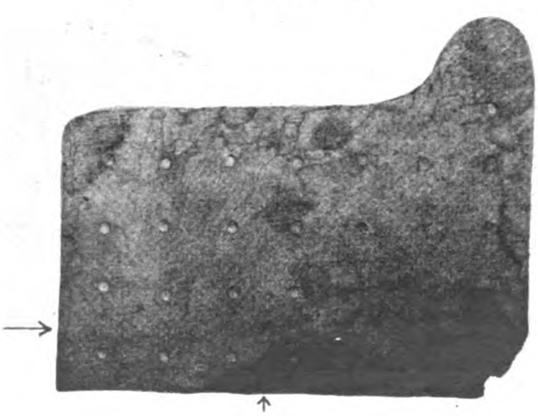

FIG. 12 B

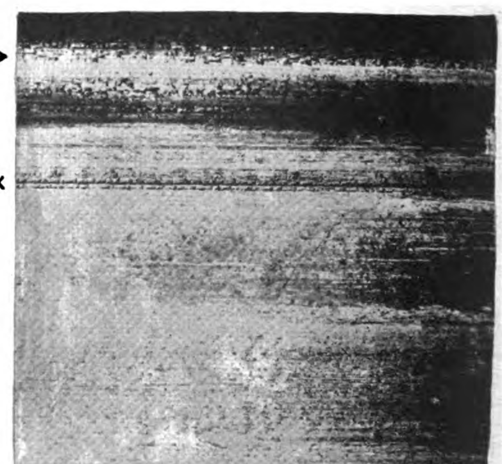

FIG. 14

Figs. 9 and 10 show where the fatigue crack splits the tire and comes to the surface of the tread. Fig. 9 is a side view; the crack extended about six inches lengthwise of the tread from the fracture, the cross section of which is shown in Fig. 1. Fig. 10 is a view looking down on the tread of the tire. The crack is shown extending lengthwise near the right-hand side and also crosswise for most of the width of the tire.

It so happens that fatigue cracks are quite evident in two of the fractures, Figs. 5a and 7a, in one case at the edge of the bore and in another at the edge of the counterbore, both on the flange side of the tire. Both photographs show fairly clearly the lines of fracture radiating from the fatigue crack. These started from roughnesses caused by the boring and counterboring of the tire (see Fig. 11). Had the tire not failed because of the flaw in the steel, it would undoubtedly have done so later on,

Fig. 8—Primary fracture at the left. Note that it is fairly straight and almost at right angles to the bore. Fig. 9—Looking at the side of the tire with the flange at the far side. The crack will be seen extending lengthwise along the tread, in line with the arrow. Fig. 10—View looking down on the tread of the tire, showing where the primary crack had come to the surface. For side view see Fig. 9. The crack shows quite clearly near the right side, but it actually extends in line with the arrow, almost to the dark portion at the left. Fig. 11—Note the rough machine work in the boring of the tire, and particularly in the counterbore. Fig. 12—Fracture caused by defective steel. Nucleus of the fracture at about the point where lines projected from the arrows would meet. Fig. 12a—Opposite face of fracture shown in Fig. 12. Fig. 12b—The deeply etched section reveals the defect at the nucleus of the fracture. It is at a point where lines extended from the two arrows would cross. Fig. 14—Example of a poorly turned tire. Note the rough tooling on the flange and near the throat of the flange at X.

because of these fatigue cracks. This emphasizes the fact that it is essential not only that the very best steel be used, but that every precaution be taken to insure a smooth job of machining.

Another Failure

Let us now consider another tire failure caused by a defect in the steel. This particular tire failed a little over a month after it was placed in service, new. In this case the tire was not broken into pieces, but a single break opened up. There is, therefore, no question about the primary break. Figs. 12 and 12a show the two faces of the fracture. The nucleous of the break, as indicated by the point from which sunburst radiations extend, was about 1¼ in. from the bore and two inches from the outer edge of the tire. There is in this instance really no definite fatigue crack; that the crack is progressive is indicated by the finer structure near the nucleous, the fracture gradually becoming coarser the farther it gets from the nucleous.

In the macrostructure examination, Fig. 12b, the deep etched section reveals the porous spot, about ¼ in. by $\frac{1}{32}$ in. in size, situated in about the same location as the nucleous of the fracture. Fig. 13 shows the bore of the tire. It is very rough and had it not been for the defect in the steel, would in all probability have caused a fracture of the tire later on. A rough machining job was also done on the tread of the tire, as is indicated by Fig. 14. The metal was gouged out on the throat and torn on the flange.

These are only two instances of fractures, but they are typical of others. Usually an examination of a deep etched section reveals the fault to be in approximately the same location as the nucleous of the fracture, provided the section for examination is cut within a reasonable distance either side of the fracture.

Locomotive Wheel Centers

There is another matter that should be given consideration and that is the effect of the wheel center being out-of-round. Steel tires endure hard service, but if the tire is not in any way defective, its shrinking on a

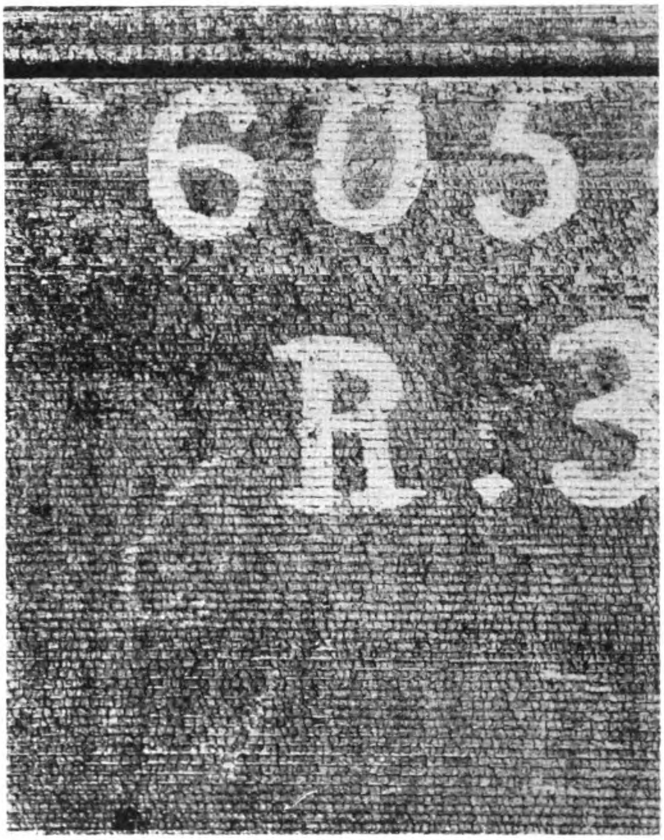

Fig. 13—Rough machine work on bore of tire

wheel center out-of-round will not necessarily cause a failure. The thing that causes failure is not excessive stresses on the tire due to service, or the lack of contact with the wheel center, or an out-of-round wheel center. Rather, it is the finish of the surface of the tire and the quality of the steel, both of which must be as nearly perfect as possible. We are careful to provide test pieces of tire steel which are finished with a high polish, and yet the tires are expected to stand up in service with surfaces almost as rough as alligator skin.

Might it not be advisable to consider the possibility of using nickel cast iron of reasonably high strength for wheel centers on locomotives? This may appear to be too daring a suggestion, but let us consider it. The damping effect of cast iron is much greater than that of steel, about 25 times as much. When a tire suffers from a blow, the shock is transmitted to the axle and may cause an axle failure. Passenger car tires are placed on cast iron wheel centers. I do not know of a broken axle that can be ascribed to failure in the wheel fit in passenger car service. They fail outside the wheel centers, but not inside the wheel fit. On locomotive axles about 50 per cent of the failures start in the wheel fit. If nickel cast iron of 55,000-lb. tensile strength is used it will be necessary to alter the design of the wheel center considerably, but there should be a saving in both axles and tires.

Corrosion of Open-Top Cars

By G. N. Schramm*, E. S. Taylerson†, and C. P. Larrabee‡

A critical study of causes discloses that 80 per cent or more of the deterioration is due to atmospheric corrosion and that the effects of leachings do not become severely destructive until bituminous coal has been in cars from four to six weeks

FOUR principal factors other than mechanical damage are responsible for the destruction of hopper cars and gondolas: (1) Atmospheric corrosion; (2) corrosion due primarily to the character of the lading; (3) schedule or method of operation of the cars as affecting the amount of atmospheric and lading corrosion, and (4) abrasion. The first three factors depend upon the three principal types of corrosion: Atmospheric, under-water and chemical corrosion.

It has been established[1] that the amount of corrosion of a steel structure in the atmosphere depends primarily on the amount of atmospheric pollution, on the length of time the structure remains wet, and on the amount of wet, solid foreign matter, such as dust or soot, which remains in contact with the structure. The rate of corrosion may be further influenced by the angle of slope of the structure, by the smoothness and tightness of joints, by the adherence of the scale or rust film which forms, by the acidity or alkalinity of the polluting liquids, and by the degree of roughness of the surface of the steel. The composition of the steel has an important bearing on the rate at which it corrodes, hence the adoption first of copper steel and now the widespread and increasing use of Cor-Ten.

Because the corrosion of steel, and of other metals, depends upon the exact conditions which surround its use—conditions which determine the kind of corroding mechanism and the rate of corrosion—it is essential to consider the conditions which may exist during the use of a particular type of car. The service to which a hopper car is subjected, for example, may vary from trip to trip, or even from time to time during the same trip. The identification of the causes of corrosion under these complicated conditions is not a simple task, but the determination of the causes when the structure is under the same conditions throughout its serviceable life may provide a basis for the estimation of the amount of corrosion under complicated conditions. If this appears impossible, such a consideration will at least facilitate the estimation of the durability of different kinds of steel under identical conditions.

Open-top cars are used for the transportation and storage of coal, coke, cinders, sand, stone, etc., some of which are more corrosive to the cars than others. Severe corrosion cannot take place, however, when the car sides and bottoms are covered by these commodities, unless the lading is wet. If the lading is wet when loaded or becomes wet from rainfall, then local corrosion may be initiated and rusting will proceed at a rate which depends on the character of the leachings which filter through the lading, and also on the temperature. The leachings may vary widely in their properties; those coming from coal and cinders, for example, are much more destructive than water leachings from sand and stone.

Corrosion caused by atmospheric conditions and by leachings from lading may be affected by the schedule of operation of car equipment. Cars which are stored under certain types of loads for weeks at a time or even months, may be impaired by corrosive leachings, whereas cars which are stored empty, for long periods of time, are subjected to the relatively mild atmospheric type of corrosion. Cars operating in normal service are, of course, subjected to both atmospheric and some degree of lading corrosion, but the latter will not prove serious except in those cases where, due to faulty design, particles of lading are trapped in seams or pockets.

Atmospheric Corrosion

The corrosion of steel cars is due primarily to exposure to atmospheric conditions. The Freight Traffic Report of the Federal Coordinator of Transportation[2] shows that the average period from the time freight cars were placed for lading until released by consignee was 6¼ days for gondola and hopper cars. Other statistics show that in 1930 the number of carloads of freight carried in hopper and gondola cars was approximately 14,219,000, and the total number of hopper and gondola cars, railroad and private, was 947,724. This would require an average of 15 trips per year by each hopper or gondola car. Since chemical action stops when the lading freezes and since freezing temperatures prevail in the Middle Atlantic States and other Northern states during approximately one-fourth of the year, the average number of trips during which a car may be exposed to lading corrosion is correspondingly reduced to 11¼. Further, since rain falls during approximately one-third of the days of the remaining nine months, it may be estimated that lading will become wet after a lapse of one-third of the average number of days during which it is under load. If it is assumed that the car is under load during the 6.25 days from the time it is placed until it is released, although 4.7 days is probably more accurate, the lading will probably be subject to rainfall after 2.08 days. The lading will probably be wet during the remainder of the trip, if average precipitation is heavy enough to saturate the contents, and the average period during which the car is susceptible to lading corrosion is then two-thirds of the time it is loaded, or an average of

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[1] The Influence of Rainfall and Smoke on the Corrosion of Iron and Steel, by G. N. Schramm and E. S. Taylerson, Symposium on the Outdoor Weathering of Metals and Metal Coatings, American Society for Testing Materials, 1934.

[2] Freight Traffic Report, Section of Transportation Service, Federal Coordinator of Transportation, Volume 1, page 88.

4.17 days per trip, or, on the basis of 11.25 trips per year during non-freezing weather, 47 days a year. Of the 14,219,000 hopper and gondola carloads originated in 1930, only 6,024,963 were bituminous coal; that is, only 42.4 per cent of all hopper and gondola loads consisted of bituminous coal. Therefore, if a car is susceptible to corrosion by all kinds of wet lading during 47 days a year, it may be subjected to wet bituminous coal corrosion during an average of only 20 days a year.

These figures are rough approximations only and are subject to wide variation, but even if the period of susceptibility to bituminous coal corrosion is trebled (to 60 days) they indicate generally that coal, if loaded dry, can be the agent responsible for the corrosion of an open-top car, in average intermittent service, only over a very short period of time—a period probably too short to be extremely harmful. However, if the car is exposed to wet coal continuously for a single period of 60 days during the year, corrosive attack may be severe.

Since steel corrodes only when wet, coal or other lading retained in pockets or at joints in an open-top car increases corrosion by greatly prolonging the time the structure remains wet. Therefore, every attempt should be made to obtain complete removal, or the car so designed that a minimum of lading is retained in the car.

Examination of the corrosion products in the scale on the sheets of an old hopper car has shown them to be substantially the same as the rust which forms on steel that has been exposed only to atmospheric conditions. There is no evidence to indicate that this rust was formed by any means other than atmospheric conditions. The amount of sulphur (sulphate), for example, in scale removed from five hopper cars of widely different age and service was 0.18, 0.22, 0.35, 0.25 and 0.41 per cent, while the sulphate sulphur from corrosion products which formed on copper steel exposed only to an industrial atmosphere was slightly greater than any of these figures—0.45 per cent.

The destruction of hopper cars by coal is probably greatly over-emphasized, much of the deterioration by other corrosive conditions being held to be due to coal. It has been said that hopper cars have been destroyed within six months by the leachings from soft coal. As previously stated, "The very fact that some of these cases have been recounted on several occasions demonstrates the unusualness of the phenomenon, but the most striking proof that these are unusual cases rests on the fact that the hundreds of thousands of cars in normal service have not been affected by such severe corrosion in a short time."[3] It is probable that the cases which have commanded attention involved cars which had already received considerable service before being subjected to long-time storage.

If it is accepted that atmospheric corrosion, lading corrosion, the schedule of car operations, and abrasion are responsible for the destruction of cars, attention may be given to the methods of combatting such destruction. The schedule of car operations should provide for full and empty service without long periods of storage under load, particularly of coal and cinders. The character of the lading cannot be changed, but cars should be unloaded promptly.

Low-Alloy High-Strength Steels

Atmospheric conditions cannot be changed, but steels which are more resistant to severe industrial atmospheres than mild or copper steels can be and are being used extensively to provide equipment which is more durable than that constructed of the usual steels. As described by Whetzel,[4] corrosion-resistant high-tensile steels are being used by many railroads to combat the problems arising from the rapid destruction of ordinary steel equipment. The composition and physical properties of Cor-Ten, the most widely used steel of this type, have been described elsewhere.[5]

Coal Corrosion

The corrosion of steel cars by coal depends largely on the kind of coal, and the length of time coal is stored in a wet condition in the cars. Long storage permits two corrosion mechanisms to act on metal parts: (1) Attack by leachings which contain appreciable amounts of ferric sulphate, and (2) corrosion set up by the constant physical contact of particles of wet coal against the metal sides and bottoms.

Solid particles in constant contact with metals which are continually wet, produce oxygen concentration cells or salt concentration cells in which the concentration of either salt or oxygen dissolved in the water under the particle differs from that in the water adjacent to the particle. This difference in concentration results in local electrolytic or battery action and causes and promotes corrosion of the metal under the particle.

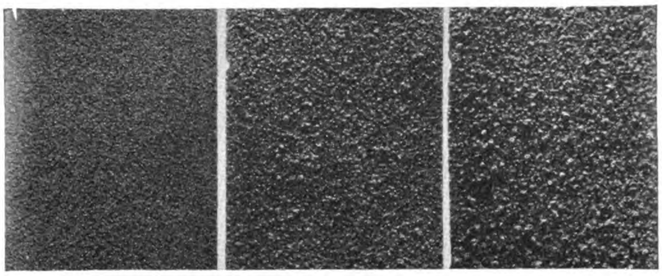


Fig. 1—Rusted samples of Cor-Ten (left), copper steel (center), and plain steel (right) after three years in an industrial atmosphere

These two forms of destruction—attack by leachings and attack by particle contact—react on nearly all metals and are not to be construed as pertaining to steel alone. Contact corrosion may also result from the contact of other kinds of wet particles, such as sand or stone, against metal surfaces, but in the case of stored coal, ferrice-sulphate corrosion conceivably may proceed without contact corrosion. The size of the material of which the lading is composed has also an important influence on the extent of contact corrosion and on the length of time the lading remains wet. Lading consisting of material of small size may produce a greater amount of corrosion.

Several tests have been made to determine the rate of corrosion of different kinds of steel by wet coal. In cooperation with one of the eastern railroads, clean (pickled) pieces of different steels were fastened to the bottoms and sides of hopper cars which were subsequently loaded with coal and the coal wet with sufficient water to cause a small, but continuous flow of leachings. The cars were kept under load for a period of six months. A careful study of the results of this test shows that it would be necessary to subject a scale-free hopper car to ten periods of similarly severe corrosion to dissolve completely the sides and bottoms. It is estimated, however, that perforation of the plates or sheets caused by pitting would be extensive enough to require replacement of the sheets after not more than five such periods of exposure. Under the most severe

[3] From a paper on "Cor-Ten—A High-Tensile Corrosion-Resisting Steel for Railroad Equipment," by R. F. Johnston and G. N. Schramm, presented before the Railway Club of Pittsburgh, November, 1934.

[4] Modern Steels and Weight Reduction, by J. C. Whetzel. American Iron and Steel Institute, May 23, 1935.

[5] New Alloy Steels and Their Application to Car Equipment, by G. N. Schramm, E. S. Taylerson, and A. F. Stuebing, Railway Age, December 8, 1934, page 761.

conditions as represented by a test of this kind, in which pickled sheets were subjected to continuously wet coal, the car body might require replacement in approximately 2½ years. The plates in the bodies of conventional hopper and gondola cars remain serviceable for approximately 9 to 12 years, the exact length of time varying with the kind of steel and the particular service conditions. Destruction of the plates by the severe corrosion induced by stored wet coal for repeated periods of six months' duration may occur; therefore, in only approximately one-fifth of the time of average car "life."

In another test made by a mid-western railroad two hopper cars, one constructed of Cor-Ten and the other of copper steel, were allowed to stand loaded for six months with two sizes of coal containing 2.5 per cent sulphur. The decrease in thickness of the plates in different parts of the cars was measured by a micrometer. The average loss in thickness was 0.0014 in. for

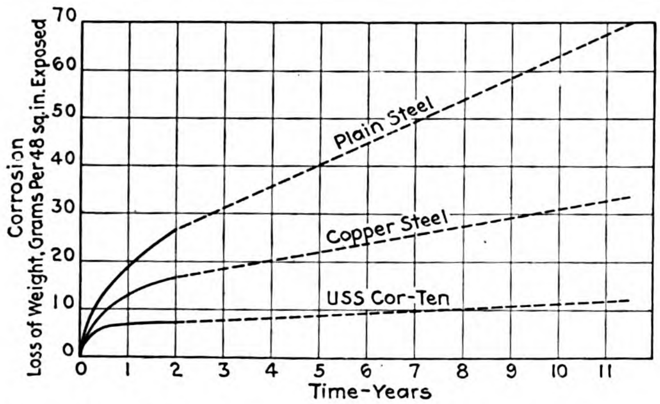


Fig. 2—The relative corrosion resistance of Cor-Ten, copper steel and plain steel in an industrial atmosphere

the Cor-Ten car and 0.0030 in. for the copper-steel car. The largest loss in thickness occurred in that part of the car containing coal screenings, the loss being 0.0037 in. for Cor-Ten and 0.0072 in. for the copper steel. This would indicate that under the most severe conditions the plate would be completely destroyed in from 67 to 35 such storage periods, depending upon the kind of steel used in the construction of the car. Perforation at local points of attack would occur very much sooner, such perforation necessitating the removal of the car from service. These results are as nearly concordant with those obtained on the eastern railroad as could be expected under the radically different conditions of the two tests.

To estimate the proportion of corrosive action in freight cars which is due to coal leachings, several factors must be considered. As demonstrated above, the average exposure to leachings from wet coal during non-freezing weather is only 4.77 periods of 4.17 days in each year. As will be shown later, the corrosive action set up in the first month of storage, even with coal high in sulphur, is only one-thirtieth as severe as the average corrosive action for the first six months of storage due to the fact that a period of approximately one month is required for the formation of severely corrosive leachings. Many coals have low sulphur content and the leachings which form from such coals may be only mildly corrosive. In normal coal-car service the interval between exposure to coal permits the formation of a rust film which serves as a partial protection against the action of the leachings. When cars are loaded and emptied frequently contact corrosion is distributed more uniformly over the plates and does not cause such severe local pitting as occurs when coal remains stationary in a car for a long period.

During the normal life of the plates in open-top cars, a period of about 12 years, coal corrosion may act for an average of 4.77 periods of 4.17 days each year, or 57 periods of 4.17 days in 12 years. Provided no periods of exposure to leachings are over one month, the corrosive action due to wet coal during the entire 12 years would be equivalent to only about one-thirtieth of one period of six months under continuously wet lading. Even if it is assumed that the coal is so corrosive that it would perforate the plates in six months if stored, the effect of coal leachings in normal service would account for the loss of only about one-thirtieth or less than 4 per cent of the plate. If the car is in coal service exclusively, the corrosion attributable to coal leachings would not normally cause the loss of more than 10 per cent of the plate. The other 90 per cent of the deterioration must necessarily be ascribed to other corrosive agents or mechanical damage.

It appears logical to believe that this major destruction is brought about by exposure to the atmosphere and that the fundamental method of obtaining greater serviceability is to construct the cars of a steel that is more resistant to atmospheric corrosion than copper steel. Those low-alloy high-tensile steels which are actually two to three times more resistant to severe industrial atmospheres than copper steel will provide much greater serviceability.

Tests carried out by storing wet coal in hopper cars produce conditions which are radically different from those which usually exist and, since service conditions must be duplicated in order to determine the relative serviceability of different materials of construction, it follows that such tests are of questionable value. Hopper cars loaded with wet coal for test purposes will reveal only what may happen to cars when they are used for storage purposes and not what will happen in regular or normal service.

Protective Rust Films

Laboratory tests show that freshly pickled samples of steel corrode in ferric-sulphate leachings many times faster than samples which have a rust film on them. Samples of steel carrying a rust film which was formed by exposure to an industrial atmosphere for one and one-half years dissolved at a very much lower rate than freshly cleaned samples of the same steel when both were immersed in the corrosive ferric-sulphate leachings from wet coal. The difference in rate of corrosion of freshly cleaned pieces and of samples which carried a rust film is due to the protective influence of rust films. That the rust films shown in Fig. 1, which were formed in an industrial atmosphere, are protective is demonstrated by the shape of the curves shown in Fig. 2. If the films had not been protective, straight lines, showing a constant rate of corrosion, would have been obtained. It is seen, however, that the rate decreases with time, even in the case of plain steel. The extreme flatness of the Cor-Ten curve is due to the dense, hard, and adherent rust film on that material which is especially protective. This does not mean that a point is not ultimately reached at which the rate is constant, as it appears logical to believe that a rust film can be protective to only a certain extent.

A thorough test of 15 freshly pickled steels and the same number of rusted steels of identical composition buried in wet coal for a period of five months indicated that the samples having the rust films were about 42 per cent more resistant than the cleaned samples. The rust film was formed originally by exposing the pieces to a severe industrial atmosphere for one year. The pronounced difference in behavior of steel when buried

in wet coal and when immersed in the leachings which filtered from the same coal indicates the extreme sensitiveness of corrosion tests and the necessity for duplicating service conditions exactly if pertinent data are to be obtained. The protection of steels in the atmosphere, under wet coal and in ferric-sulphate leachings by an oxide, however, indicates that the rust film has an important bearing on the serviceability of steel cars.

The Nature of Coal Leachings

The corrosiveness of coal leachings is due to the ferric sulphate that is formed by the action of air and water on sulphur minerals in the coal. The chemical reactions by which this compound is formed from the iron sulphide in the coal, present as both pyrite and marcasite, are very complex. The factors that favor the formation of corrosive leachings are free access of air

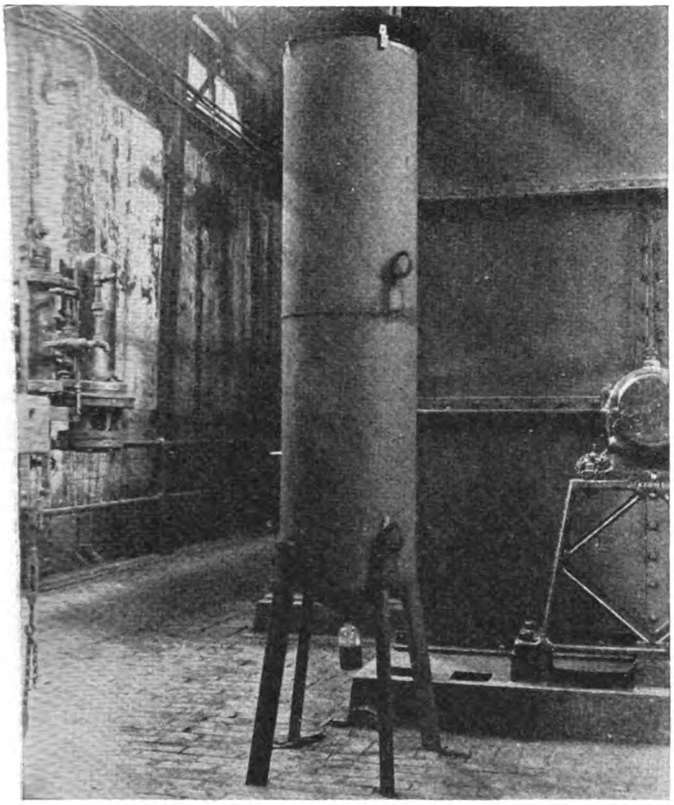


Fig. 3—Stainless-steel equipment for the study of the leachings from wet bituminous coal—The depth of the cylinder is equivalent to the average depth of coal in a hopper car

and water, fineness of the coal, amount of iron sulphide in the coal and high temperature. The last factor is very important since chemical reactions of this nature generally double their rates for each increase of approximately 20 deg. F. When ferric sulphate attacks steel or iron the product is ferrous sulphate which is an intermediate product in the oxidation of the iron sulphide to ferric sulphate. Therefore, in the case of stored coal in iron containers once the action starts it is self-accelerating until the products are washed out by heavy rainfall. Laboratory tests have shown that a comparatively weak solution of ferric sulphate is more corrosive to steel, but not to rust, than equally weak solutions of sulphuric acid.

In order to determine experimentally the rate of the chemical reactions which take place when bituminous coal remains wet for long periods of time, the stainless-steel cylinder shown in Fig. 3 was filled with thoroughly wet run-of-mine bituminous coal from which lumps over 4 in. in diameter had been removed. Obviously a plain steel container, or even a hopper car, cannot be used for this kind of test, because the leachings react with the steel before they can be collected and analyzed. The filtrate or leachings were collected in bottles suspended at the opening in the conical bottom of the cylinder. The top of the cylinder was covered in such a manner as to exclude dust but not air. It was kept in a warm boiler house throughout the test. The coal was wet twice weekly with distilled water in amounts equivalent to normal rainfall, and the collected leachings were analyzed.

The curve in Fig. 4 shows graphically the results of the test. The amount of ferric sulphate in solution did not begin to become appreciable until the coal had been in storage from four to six weeks, after which it increased rapidly, reaching a maximum after about three months. The concentration then began to fall and at the end of a year it was approximately the same as it was after only six weeks of storage. At no time during the test was sulphuric acid or ferrous sulphate found in appreciable quantities.

These data indicate that coal should not be stored wet in a hopper car for a period of time exceeding four to six weeks. Obviously this period will vary with the kind and size of coal and whether it is bituminous or anthracite and on the prevailing temperature during the storage period. Corrosion practically stops when freezing starts, and the rate is very low near freezing temperatures. This means, of course, that railroad equipment does not corrode as fast in cold weather as its does during the warm months of the year. Very hard rain storms will produce a flushing action which will cause the immediate removal of the accumulated sulphur compounds without permitting the ferric sulphate to react with the steel. This flushing action

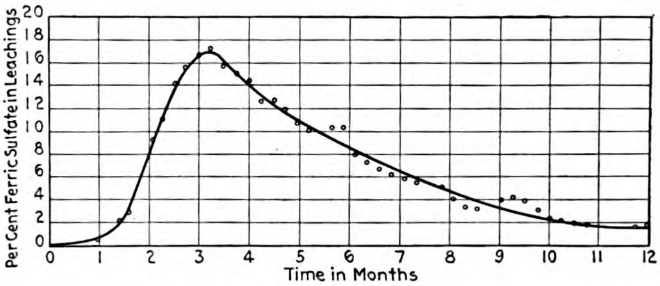


Fig. 4—The effect of time on the concentration of destructive iron compounds which leach from wet coal

will tend to increase the period of time before the leachings begin to corrode the car.

Abrasion

Tests carried out by exposing samples of several steels to the abrasive action of coke show that Cor-Ten is approximately 40 per cent more resistant to abrasion than mild steel or copper steel. These tests were made by fastening, into coke chutes, large samples of different steels which had been pickled. The resistance of this steel to abrasion is another factor which will assist in providing greater serviceability for those cars which carry abrasive loads.

Light-weight cars constructed of Cor-Ten are now in operation on a number of railroads. Examination of these cars after intensive, assigned coal and coke service, shows them to be in excellent condition. The mill scale is gradually falling away and rust films are being formed. The rate of corrosion of corresponding copper-steel and mild-steel parts appears to be much greater than that of the high-strength steel.

Considerations in Selecting Machine Tools

Few industrial organizations, whether engaged in production or transportation, have a more comprehensive and carefully developed program of machine tool replacement than the Westinghouse Electric & Manufacturing Company, if we may judge by a paper presented by L. D. Rigdon, director of equipment negotiations for this company, before the June meeting of the Machine Tool Electrification Forum at East Pittsburgh, Pa. In this paper, Mr. Rigdon explained the reasons why his company analyzes its individual machine tool requirements at the end of each year and makes a survey to determine just how many old tools are inadequate for one reason or another and how many and what types of new tools shall be bought to replace them.

Some of the questions which the Westinghouse organization asks itself in choosing a new tool and which may be of suggestive value to railway machine tool buyers are as follows:

Do we know from past experience that, while the machine looks good on paper, repair bills are high, and down time, due to repairs, is excessive with corresponding loss in production?

Do the manufacturers give service? That is, when difficulties arise in connection with the operation of their machine, do they have their representative call to make the necessary corrections in the shortest possible time?

Does the machine embody the latest improvements in design for that particular type of equipment?

Is the machine properly guarded so that a workman can operate it safely?

Is it advisable to purchase a duplicate of a machine we now have in use that goes into a line of similar machines in order to have interchangeable tool equipment and to enable us to switch operators from one machine to another without any loss in production?

Very often we send out drawings showing the piece to be machined and have the manufacturers submit quotations on the equipment they recommend, together with production estimates. In cases of this kind, we select the machine that gives the maximum production for the least amount of money expended.

The type of drive is also a factor in selecting the proper equipment in that we try to select machines to which motors have been applied so as to give the most economical operation. With the new cutting materials that have been developed in the last several years, speeds and feeds have been increased, and the type of drive will very often affect the range of these speeds and feeds; for example:—a machine driven by an adjustable speed d.c. motor or a multiple speed a.c. motor.

Is the tooling equipment on one machine easier to set up than on another? This is a very important item when dealing with machines that are used for short order work where pieces come through in small lots.

Are we justified in the purchase of a high-priced special high-production machine over a standard machine at a lower cost with a smaller production capacity? In such cases as this, a decision must be reached on the following points:

(a) Do we have sufficient production to keep the machine busy?

(b) Will the cost per piece be low enough to justify the additional cost of the special machine?

(c) Will the piece be in production a sufficient number of years to pay for the machine, as it will undoubtedly be obsolete and have to be scrapped if the piece is no longer manufactured.

(d) In case the design of the piece is changed, can the machine be changed over to manufacture a new design without involving a large expenditure of money?

(e) Is the company offering the machine reliable—that is, are they likely to be in business for a number of years so that equipment purchased from them can be duplicated and repair parts secured when necessary? This does not mean that the company has to be unusually large with respect to size, etc., but it must be well established, have good financial rating and have a personnel with the ability to keep the equipment up to date.

Constant-Pressure Valve for Passenger Car Use

The Vapor Car Heating Company, Chicago, has recently developed a constant-pressure valve designed for use between high-pressure steam train lines on passenger cars and Vapor regulators which supply steam to the heating system. The purpose of this constant pressure valve is to maintain a uniform delivery of steam through Vapor regulators regardless of train-line pressures.

It eliminates excessive blow and waste of steam at the regulators, speeds up the passage of steam to the rear of long trains, and reduces wire drawing and wear of Vapor regulator inlet valve parts and at the same time increases life of regulator diaphragms. Perhaps the most important function of this constant pressure valve is the fact that it prevents the necessity of readjusting the set screw of Vapor regulators to compensate for varying train-line pressures. In other words, passenger cars may be operated at either the head end or rear end of trains as desired without making any change in the set screw adjustments of any of the Vapor regulators in the train.

Vapor No. 244 valve for use in maintaining uniform pressure in passenger-car steam-heating lines

The Vapor constant-pressure valve No. 244 once applied requires no further attention—it automatically delivers steam to the regulator at a maximum of approximately 40 lb.

The valve is furnished with inlet and outlet union connections and is thus easily applied in the supply pipe between steam train line and regulator.

Younger Men's Viewpoint

Why they read technical publications, and what they look for

YOUNGER men almost disappeared from the railroad ranks during the depression and only now, as conditions are improving, are they being recruited in any considerable numbers. It is high time that this is being done; moreover, special attention must be given to the training of these young men, for there promises to be a pressing need for skilled workers in the days ahead; indeed it is already beginning to be felt in some places.

From the ranks of these workers will come many supervisors. Because of the possibilities of radical changes in equipment design and of changed practices, it will be necessary for the worker of the future, and the supervisor and railway officer as well, to be much more thoroughly and carefully trained for his work than has been true in the past.

The *Railway Mechanical Engineer* is deeply concerned in the welfare of the young men who are now starting in at the bottom of the ladder. While this publication is designed to satisfy the needs of the officers and supervisors of the mechanical department, it is being read by a number of the more ambitious shop apprentices. With a view to finding out what use they were making of the paper—with the co-operation of M. H. Westbrook, shop superintendent of the Grand Trunk Western, at Battle Creek, Mich.—a little contest was staged, in which the apprentices at that point were asked to express, in a statement of about 250 words, how they expected to benefit by becoming regular readers of the *Railway Mechanical Engineer*.

Mr. Westbrook, who has always taken a keen personal interest in the apprentices in his shop and has encouraged them to read the technical publications, properly feels that they must have a reasonable amount of encouragement if they are to cultivate the habit of reading such papers and in understanding how to make the best use of them. Fifteen of the apprentices at Battle Creek commented upon the *Railway Mechanical Engineer*. Some of the high spots in their expressions follow.

Ernest Nightingale
Second Year Machinist Apprentice

If one is to gain anything of value from reading a magazine regularly, the publication should have the following characteristics: First, it should have educational value. It should contain news, both technical and personal, of particular interest to those for whom the magazine is primarily intended. It should also be entertaining, to a certain degree, lest it become too dry and technical.

The *Railway Mechanical Engineer* fills these qualifications admirably well. The articles on technical subjects and those describing the tools and methods of shop practice on various roads are of special value to one engaged in learning locomotive or car maintenance. The editorials and discussions of laws pertaining to railway operation also contribute greatly to the educational value of the paper.

The descriptions of new equipment, and particularly the advertising section, keep one well informed on the latest developments in road and shop equipment. The Readers' page and the Gleanings from the Editor's Mail give a cross-section of thought from the average railroad men all over the country.

The element of entertainment is furnished in a manner that leaves very little to be desired by the Walt Wyre stories.

I shall, therefore, expect to gain a great deal and hope to become a better railway man for having become a regular reader of the *Railway Mechanical Engineer*.

Robert W. McAllan
Third Year Machinist Apprentice

I find the *Railway Mechanical Engineer* very interesting and educational. The different departments of the magazine cover almost every repair job in the railroad shops. This is all very helpful to me, being an apprentice, as it brings to realization the problems that confront fellow workmen of different crafts. The section dealing with other shops is interesting, because I can compare their methods of doing a job, using different tools or machines, and try to find out which is best, safest and with the least cost to the company.

The advertisements in the magazine are helpful in keeping in mind new tools that are being manufactured for different jobs.

Wilfred A. McCoy, Jr.
First Year Machinist Apprentice

The three issues I have, January, February and March, 1936, all seem to be crammed with new ideas. The idea of describing new methods and short cuts as used in other shops appeals to me for I believe that anyone who fails to watch his competitor and is unwilling to accept a good idea from him, is lost at the start. It is often remarked that it is little tricks of the trade that make a master, and watching this magazine I have found it to be full of the little tricks.

Joseph J. Plohans
Third Year Machinist Apprentice

This magazine evidently was designed primarily for railway supervisors; but as it is my ambition, and no doubt every apprentice has the same ambition, to become a railway supervisor, I find that the information in your magazine, coupled with my immediate training, will provide a suitable background for a supervisory position in the railway shops.

F. W. Macey
Third Year Blacksmith Apprentice

The way in which I believe I will benefit from the *Railway Mechanical Engineer* is by reading all of the articles and becoming acquainted with all parts of the locomotives and their making, thus enabling me to know better the use of the different pieces I have to make.

EDITORIALS

The Influence of Diesels On Locomotive Maintenance

A question which is frequently asked these days is "What effect will the introduction of Diesel power have on the locomotive maintenance problem, particularly with reference to the character of repair methods and repair shop equipment?" Those who ask the question are, as a rule, persons who are liable, from a railroad standpoint, to come into direct contact with the job of repairing Diesel powered equipment in the near future or those who have a business interest in the sale of equipment used in railroad shops for repair work. It is a question which seems, at the outset, to be difficult to answer yet one which, after a little thought, almost answers itself.

The Diesel locomotive or rail car is a transportation facility which, for all practical considerations, has been in railroad service less than ten years. Most of the Diesel engines now in such service have been installed during the past five years. In spite of the interest in this type of power and "ballyhoo" which has surrounded its introduction to the railroad field there are today only about 200 locomotive or car power units in service. There is no reason, in this discussion, to become involved in any consideration of the economics of Diesel power so, for the sake of argument, it can safely be assumed that the experience of the railroads to date has been of a sufficiently satisfactory character that the Diesel will continue to be installed in rail service where the nature of the operations is such that it may be operated profitably. In order, then, to arrive at some conclusion as to the probable influence on locomotive maintenance (we speak of locomotive maintenance because the repair work of the immediate future will in all probability be performed in the locomotive repair shops) it is desirable to make an intelligent guess as to how many units may be installed in the years to come. Assume, for example, that not over 100 units per year are installed during the next ten years. We will, at the end of that period have a total of 1,200 units in service on the Class I roads. It is assumed, of course, that none will be retired during that time. Conservative estimates place the replacement ratio of Diesel over steam at 1:1.5. In other words, each Diesel installed replaces one and one-half steam locomotives. So, at the end of ten years it is quite probable that there will be about 1,200 Diesel-powered units as compared with approximately 40,000 steam locomotives; in other words, 33 steam locomotives to be repaired for each Diesel that goes through the shop. Any shop superintendent or general foreman in charge of a shop today repairing 33 locomotives a month can vouch for the statement that one Diesel a month would not set up any serious complications in his shop. Of course it might be argued that ten years ago there were 64,000 steam locomotives whereas today there are only 43,000 and that a continuation along the same path of progress might produce a situation ten years hence where there would be, say, 2,000 Diesels and only 30,000 steam locomotives. That would mean that in a shop repairing 30 locomotives a month two would be Diesels. Still, no serious complications appear from a shop standpoint.

There is something else to consider. A Diesel-electric locomotive is, after all, a machine consisting of three major parts: The mechanical equipment, such as frames, trucks, brake equipment, draft gear, etc.; the electrical equipment and, finally, the Diesel engine. When this question is all boiled down it resolves itself into the fact that two-thirds of the Diesel-electric locomotive consists of a type of equipment with which the railroad shop has been dealing for from 30 to 90 years. The remaining third, the Diesel engine, constitutes the only new problem of maintenance. So, it seems only reasonable to say that if one can predict what may be the influence of the Diesel engine on shop methods and facilities the original question is answered.

The Diesel engine, from a repair-shop standpoint, is a problem of parts replacement—parts that are either purchased from the original builder of the engine or manufactured in the railroad shop. The parts of an engine which will in all probability need replacement most frequently are cylinder liners, cylinder heads, valves, fuel nozzles, rocker arms, push rods, crank shafts, connecting rods, cam shafts, crank-shaft bearings, pistons, piston rings and wrist pins. (This list is not, in any sense, intended to indicate the order of renewal frequency.) With the exception of crank shafts, cam shafts and cylinder liners, even assuming all such parts were manufactured in the railroad shop, there is very little, if any, machine work involved that could not be handled on existing machines. It is doubtful if any railroad could justify the installation of machine-tool equipment for the manufacture of the three parts mentioned in view of the probable small volume of work involved.

In conclusion, from a casual analysis of the problem of Diesel maintenance it does not appear that, in the next ten years at least, the introduction of the Diesel will greatly add or detract from the amount of repair work, considered from the standpoint of the shop as a whole, that the railroads will be required to perform. More important is the fact that unless some unforeseen development takes place to cause the rapid obsolescence of the steam locomotive the volume of Diesel main-

tenance, by comparison with that of steam, will be so small as not to affect seriously the character of shop methods and facilities.

Cultivating The Public

The railroads have learned from hard experience that they cannot in this day and generation sell transportation in the cold, matter-of-fact way in which some postal clerks sell postage stamps. In the first place, the railroads now have and for some time have had aggressive and spirited competition, and these competitors use modern, up-to-date methods and lots of courtesy in merchandising their product. Then, too, even public servants are awakening to the fact that courtesy pays —that the American public likes to be treated with consideration, and that sometimes it may be provoked to the point where it loses its indifference and insists on demonstrating that it is the real boss.

Some railroads have made excellent progress in cultivating the public and earning its good will. Others have been less active and far less successful in this respect. The forces of a railroad are so scattered and such a comparatively large proportion of the employees come in intimate contact with the public, that the entire organization must be fully sold on a policy or a program for improving public relations, if any real progress is to be made. Unfortunately, wage adjustments and working conditions on the railroads have become too largely a matter of public interference and regulation, and politics have entered into the situation to an alarming degree.

Possibly this is one reason why many of the employees are seemingly indifferent to the welfare of their railroad, or at least fail to take an interest in extending those courtesies to the public that have been used with such marked success by merchandisers in other fields. A clerk or sales representative in a store would be cleaned out in a hurry, if he or she were as mechanical, or even grouchy, in dealing with customers as are some railroad employees. This is one reason why competing forms of transportation, which pay lower wages, insist upon longer working hours and maintain relatively poor working conditions, have been so successful in taking business away from the railroads; they have at least extended courtesies and shown a regard for the welfare and comfort of their customers which has been lacking on the part of too many railroad employees.

Are not ambitious railroad labor leaders making a serious mistake in many of their attacks upon railroad managements, and particularly in regard to their aggressive political activities? It is doubtful whether the rank and file, in general, endorse the position and sentiment of some of these leaders, such, for instance, as their advocacy of government ownership of the railroads. Would these leaders not serve the membership of their organizations better by encouraging a loyalty to their employers, which would encourage them to give better service to the public?

One of the departments of the Association of American Railroads, which promises to be a vital factor in cultivating good will on the part of both the public and the employees toward the railroads, is its public relations staff. This has recently been enlarged and has adopted an ambitious and comprehensive program which includes 25 projects and 13 services; 11 of the projects and eight of the services have already been started in operation. The project which has attracted the greatest amount of attention is the advertising in a number of the national popular magazines. To be really effective, however, such advertising must have the co-operation of every employee on the railroads.

That form of transportation is now regarded as by far the safest. This enviable position has been achieved only by enthusiastic co-operation on the part of all of the employees. The railroads in their national advertising program are emphasizing safety, and "friendliness too." That is the spirit which will win out. Some railroads have made splendid progress in this direction, but, unfortunately, too many employees have failed to be continually thoughtful of the interests of the traveling public. All of the advertising in the world cannot overcome a handicap of this sort, and yet it must be overcome if the railroads are to prosper and continue to be the dominant factor in mass transportation.

Frequently an employee will respond to suggestions made by his fellow employees more quickly than when such suggestions come from other sources. Now is the time for the thoughtful employees, who are interested in the welfare of their particular railroad, to use their influence with the other employees, if they know that the attitude or actions of such employees are irritating the public. Many of the mechanical department employees do not personally come in contact with the traveling public. Their contribution must be that of doing everything they can to make the equipment safe, comfortable and attractive; they can also, however, use their personal influence in getting employees whom they know and who do come in contact with the public, to realize the importance of extending the courtesies and consideration which are due to any purchaser of service or merchandise.

A Remarkable Locomotive

The Norfolk & Western single-expansion articulated locomotive which is described in this issue is an interesting development in steam motive power in a number of particulars. One of the details of design to which attention should be called is the new method of roller-bearing application to the driving wheels by which the bearings are mounted within the wheel hubs and the pedestal-bearing construction is considerably simplified.

The most striking fact about these locomotives is

their performance in which they have demonstrated their ability to develop over 6,000 drawbar horsepower through a range of speed from 32 to 57 miles an hour. A maximum of 6,300 drawbar horsepower was developed at 45 miles an hour. This is believed to be the highest horsepower on record for a steam locomotive in America and probably in the world.

This locomotive bears an interesting relation with two other types of motive power for high-capacity freight service. About eight years ago a number of eight-coupled single-expansion articulated locomotives were built, the larger of which out-rank the N. & W. locomotive in weight, heating surface and tractive force. Notable examples of this group are the Northern Pacific and Great Northern locomotives. The former has a weight on drivers of 553,000 lb., a total engine weight of 717,000 lb., a combined heating surface of almost 10,900 sq. ft., and a rated tractive force of 140,000 lb. The latter has a weight of 544,000 lb. on drivers and 631,000 lb. total engine, with a combined heating surface of approximately 11,400 sq. ft. and 146,000 lb. tractive force.

Others of the early single-expansion eight-coupled articulated locomotives which compare closely with the N. & W. locomotive in weight cannot compare with it in capacity because of the smaller firebox and boiler proportions. The locomotive which compares most closely with the N. & W. in boiler proportions has considerably higher weights. This is the Southern Pacific oil-burning 4-8-8-2 type built in 1928 which weighs 614,600 lb., of which 475,200 lb. are on the drivers. It has a combined heating surface of 9,475 sq. ft. and a firebox with 139 sq. ft. of nominal grate area.

In two respects, other than wheel arrangement, the N. & W. locomotive differs from the earlier single-expansion locomotives. These are its larger driving-wheel diameter and higher boiler pressure. The earlier locomotives all have 63-in. or 63½-in. drivers, while those of the N. & W. locomotive are 70 in. in diameter. Its boiler pressure is 275 lb., while that on the earlier locomotives is 235 to 250 lb.

The other comparison is with the single-unit, ten- and twelve-coupled locomotives which were built at about the same period or a few years later. The Chesapeake & Ohio ten-coupled locomotive built in 1930 compares closely to the N. & W. locomotive in boiler proportions and total weight, but is considerably lighter on drivers. The driving-wheel diameter is 69 in. Including the booster with which the locomotive is equipped, however, its tractive force slightly exceeds that of the N. & W. locomotive. One of these locomotives, altered by increasing the cylinder diameter from 29 in. to 29½ in. and by increasing the boiler pressure from 260 lb. to 265 lb. so that its rated combined tractive force is 110,000 lb. (3,400 lb. more than the rating of the locomotive as originally built), developed a maximum of 5,855 indicated horsepower at 33 miles an hour in a test during which it averaged 5,400 horsepower over a considerable period. This is an indicated horsepower for each 96.7 lb. of total engine weight.

The Union Pacific twelve-coupled locomotives have about 1,000 sq. ft. less combined heating surface than the N. & W. locomotive and are somewhat lighter both in weight on drivers and in total engine weight. The driving wheels are 67 in. in diameter and the boiler pressure 220 lb. With a tractive force of about 96,700 lb. these locomotives, in service, are reported to have developed an indicated horsepower of over 4,900—a horsepower for a fraction less than 101 lb. of total engine weight.

The indicated horsepower of these locomotives should be compared with the indicated horsepower of the N. & W. locomotive. While the figures are not yet a matter of record, they can scarcely be much below 7,000. For a freight locomotive, particularly for an articulated locomotive, the development of an indicated horsepower with less than 85 lb. of total engine weight and a drawbar horsepower with 90.5 lb. of total engine weight is a notable achievement. A limit of 100 lb. per drawbar horsepower is not exceeded within a speed range of about 30 miles an hour.

NEW BOOKS

ENGINEERING QUESTIONS AND ANSWERS. *Published by Emmott & Co., Ltd., at the offices of the Mechanical World, 28 Bedford street, London, W. C. 2. 176 pages 7½ in. by 9½ in. Cardboard bound. Price, 6 shillings.*

This book is the first of a proposed series in answer to frequent request that the questions and answers section of the (British) Mechanical World and Engineering Record be published in book form. The volume starts with the beginning of the year 1934 and covers part of 1935, the projected second volume to continue from that point and carry on with the answers of 1936. The questions originated out of the difficulties and problems encountered by engineers in the course of their work.

DIESEL LOCOMOTIVES AND RAIL CARS. *By Brian Reed. Published by the Locomotive Publishing Company, Ltd., 3, Amen Corner, E. C. 4. 190 pages, 8½ in. by 5½ in., cloth binding. Price six shillings.*

In introducing this book, the author ventures the opinion that progress in employing rail traction units powered by heavy oil engines has not been slow and that from a technical point of view the experimental stage has been passed, except in the case of engines of 2,000 hp. and upwards. The book deals with the advantages of Diesel traction and the development of the use of Diesel power, both in this country and Europe. A chapter on railway requirements for Diesel power goes into considerable detail in outlining the requirements of the service and the type of power which has been adapted to it. Succeeding chapters in the book contain descriptions of well-known engines as well as information on engine auxiliaries and transmission systems—mechanical, hydraulic and electrical.

THE READER'S PAGE

Some Bird!!!

To the Editor:

Car Foreman T. J. Neubauer at Port Huron, Mich., submits the following in reply to the query on page 313 of your July issue as to "What is a Car Foreman?"

"A car foreman is a sort of bird. In fact he is several kinds of bird.

"First of all he must be able to see in the dark, so let's call him an owl. At night while other supervisors are home snoring or out making whoopee, the car foreman must keep his eagle eye on the business of the road.

"He must also be a duck and be ready to weather the storms while back shopmen and other railroad employees are able to sit comfortably by their firesides and peacefully smoke their pipes.

"He must be a species of hawk and be ready to pounce on other lines for trying to slip defects over which they should have taken care of themselves.

"Last, but by no means least, he must be a goose and take unbearable brow beatings from master car builders, A.A.R. inspectors, I.C.C. men, main office timekeepers, general superintendents and countless others, whose chief duty is to prey, like vultures, on car foremen.

"Therefore, I would say he is a bird of a very rare species. From whence he comes no one knows, but his chief duty is to help put the eagle on the American dollar for his railroad."

Charles Claudy,
Master Car Builder.

Another Enginehouse Foreman Philosophizes

To the Editor:

Having read the article "So You'd Rather Be a Puritan" in the *Railway Mechanical Engineer* for July, 1936, page 317, I'm moved to say hats off to the philosopher who so ably sums up the discussion which originated with the publishing of the "Roundhouse Foreman's Daily Log" in the *Railway Mechanical Engineer* for May, 1935, page 207.

Several years ago I heard an old timer remark that he thought the roundhouse foreman was the most abused person on the railroad. The statement may be a bit overdrawn, but, supposing it is true in part, I would like to ask who is at fault for things remaining as they are at the present time? Are we to assume that the foremen continue to work as they are just because they are too busy to undertake the extra effort required to bring about the conditions desired? Or possibly it is because of a lack of leadership among the supervisory forces, in that nobody wants to risk bringing down the wrath of his superior officers and thus reduce his chances of further promotion by being classed as a radical from that time on?

Perhaps it is due to indifference on the part of those foremen at smaller terminals having it a bit easier than those employed at the larger points where the work is much heavier, as is evidenced by the comment of one foreman who stated that he was able to take part in a number of social activities, and his church work was all up in good shape and his job was all that could be desired.

At the time of my promotion it seemed that the higher salary was the means of bringing about a lot of things, such as owning a house, but as I cast about me and from what I can learn from personal contact with other foremen, it seems that in a great many cases they spend as they earn and none of them is on the road to wealth. On the other hand, the man at the bench by a little self denial is going right along and making the regular payments on his home and, since he works an eight-hour day, he has ample time to do a little landscaping or follow up anyone of a dozen hobbies. The man at the bench keeps his health and, as I see it, is really getting ahead faster than the man who is working unreasonable hours for the sake of bearing a title—and a minor one at that.

As for continued promotion the chances are becoming more remote due to the closing of the smaller enginehouses and extending the locomotive runs along with the consolidating of division points; the increase in work resulting therefrom isn't helping old Jim Evans get home any earlier each evening. Tragic, is it not, when you stop to think that we pass this way but once.

The benefits of the shorter workday are known everywhere, yet I can recall the dire predictions made by the skeptics when the 16-hour law was passed to regulate the working hours of train and enginemen. We can look back and see that the decrease in train accidents has been brought about by having men handling trains who are fully rested and alert at all times. Wouldn't it be logical to assume that a reduction in shopmen's injuries will take place when the roundhouses are run by men who are fully rested and are right out in front?

Supervisors generally know how much hard work they can stand and set the pace so as to be in the race at the finish of the day's work, and it can be readily seen that a foreman working eight hours a day will consistently turn out a better day's work than one working twelve or more hours per day, held back by that tired feeling that makes them sluggish in their actions and generally hard to get along with.

It seems to me that improved working conditions for foremen would go far toward promoting harmony in all departments and reduce the labor turnover to a minimum; it would eventually spread to the rank and file and the general rise of efficiency would more than offset any increase in payroll incurred by putting on such extra foremen as necessary to make the eight-hour day for foremen possible.

The three shifts for foremen would make it possible for the managements of the different railroads to build up a strong personnel because of having a larger number of tested men to pick from for the more important positions.

It remains to be seen who will be the first to pioneer the venture in human engineering. There is no question but that the officers of the railroads are cognizant of the benefits to be derived from the eight-hour day, but each one of them seems to be waiting for some one else to "bell the cat."

Enginehouse Foreman.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Challenge to Enginehouse Foremen

I wager that with the most of them (enginehouse foremen) the first investment for new equipment should be right at home with themselves—an investment in new ideas, better shop practices and better established routine methods of conditioning their power. There is altogether too much patch work; any job worth doing is worth doing well—very well, in fact.

Photograph by Edward Bolsetzian, Brooklyn, N. Y. Superplenachrome Film, 1/25 second, F. 22

Pulls the C. R. R. of N. J. "Blue Comet" between New York and Atlantic City

Personal Appearance Counts

A foreman should be very careful about his personal appearance; he should never appear hurried or worried to his men, since they have much more confidence and respect for the foreman who seems to know what he is about and presents a clean-cut appearance. Foremen in the roundhouse can make a hard job out of it, or they can have a nice, snappy organization that clicks. It's up to them.

Roundhouse Supervision

If the days to come are half of what they are supposed to be the railroads will have to offer something better if they hope to attract men capable of doing what will have to be done. As motive power becomes more refined and complicated with the increasing application of electric and Diesel power, as it becomes less and less a matter of strong back and weak mind, better brains are going to be needed than are likely to respond to the invitation.

"Hell-Benders" Bust

I believe that there will eventually be a reduction in the long working hours of the supervisory forces, but I do not believe that the long hours can be directly the cause of mental and physical breakdowns. The "hat-stomper", the "arm-waver" and the "hell-bender" is, in the majority of cases, the one who breaks down. The man who is self-contained, leads instead of pushes, remembers that which should be remembered and forgets that which should be forgotten, is not going to break down mentally or physically from long working hours.

Leaders Instead of Pushers

The game of railroading is slowly turning from the side of bluff, bigotry and egotism to the side of intelligence, broad-mindedness and tolerance. This is especially true in the supervisory forces. Observe the promotions that are taking place day by day and you will note that they are men, by a high majority, who know the game; men who are intelligent; men who have gained authority not through their pull, bluff and ability to drive men, but those who through their ability and knowledge, personality and intelligence, have placed themselves out in front, so that they are leaders instead of pushers.

The Supervisor as an Educator

A supervisor will go far if he will learn to encourage his men for good work well done, and to instruct the ones that are lagging behind. . . . I never fail to speak a word of encouragement and compliment the man who does good work; or when I have a man who is breaking in on a new job, or is servicing some bit of equipment that he is not familiar with, to take the time to explain and show him how and what to do. If he is a little slow to catch on, I get him the manufacturer's manual or pamphlet which describes the equipment and methods for adjusting it properly, or servicing it.

Who Can Answer This One?

Here is a poser which my wheel foreman put up to me today. Who can answer it? Engine No. 2000 is being fitted with two new 60-in. steel wheels, both of which were poured from the same mixture and in the same heat. Each wheel was bored perfectly round and parallel and as smooth as possible, to a diameter of 10 in. No tool marks were visible. The axle was turned smoothly and accurately with an allowance of .0170 in. The first wheel went on at a pressure of 180 tons, which was O. K. A pressure of 210 tons was reached with the other wheel and it still had four inches to go. Thinking it might have seized, we pulled it off, but found it in good condition. We then reduced the allowance to .0120 in. and it required 195 tons to press the wheel into place. This is excessive, but it was allowed to pass. The "lubrication" used was A.R.A. standard—12 lb. of white lead to one gallon of boiled linseed oil, freshly mixed. What caused this variation? Personally, I confirmed the amount of the tolerances, using both outside and inside micrometers.

IN THE BACK SHOP AND ENGINEHOUSE

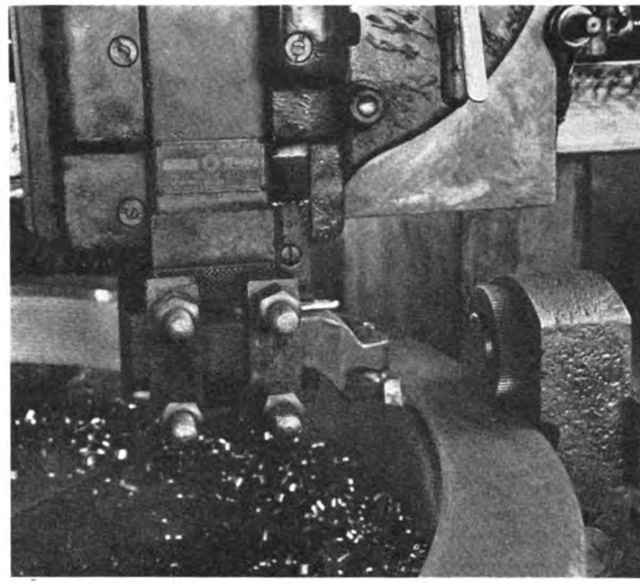
Battle Creek Shop Kinks

Three devices, successfully used at the Battle Creek, Mich., shops of the Grand Trunk Western, are shown in the illustrations.

The first of these is a special fixture used for milling shoes and wedges or cross head slippers four at one time on a milling machine. The feature of this device is that hand-clamping is eliminated, each of the shoes, or wedges as the case may be, being supported on special jaws which slide in a T-slot and may be drawn together under heavy pressure by means of a 2-in. steel bar and yoke suitably connected to an air brake cylinder clamped to the milling machine table.

In operation the four shoes or wedges are inserted between the fixture jaws, air pressure applied, and all of the jaws and shoes drawn tight against the fixed jaw at the left end of the device. The hold-down bolt in each jaw is then tightened and the shoes and wedges are thus automatically positioned and held tight ready for the milling operation with practically no hand adjustment or tightening of clamps. It is estimated that the use of this fixture saves approximately 50 per cent in the setup time.

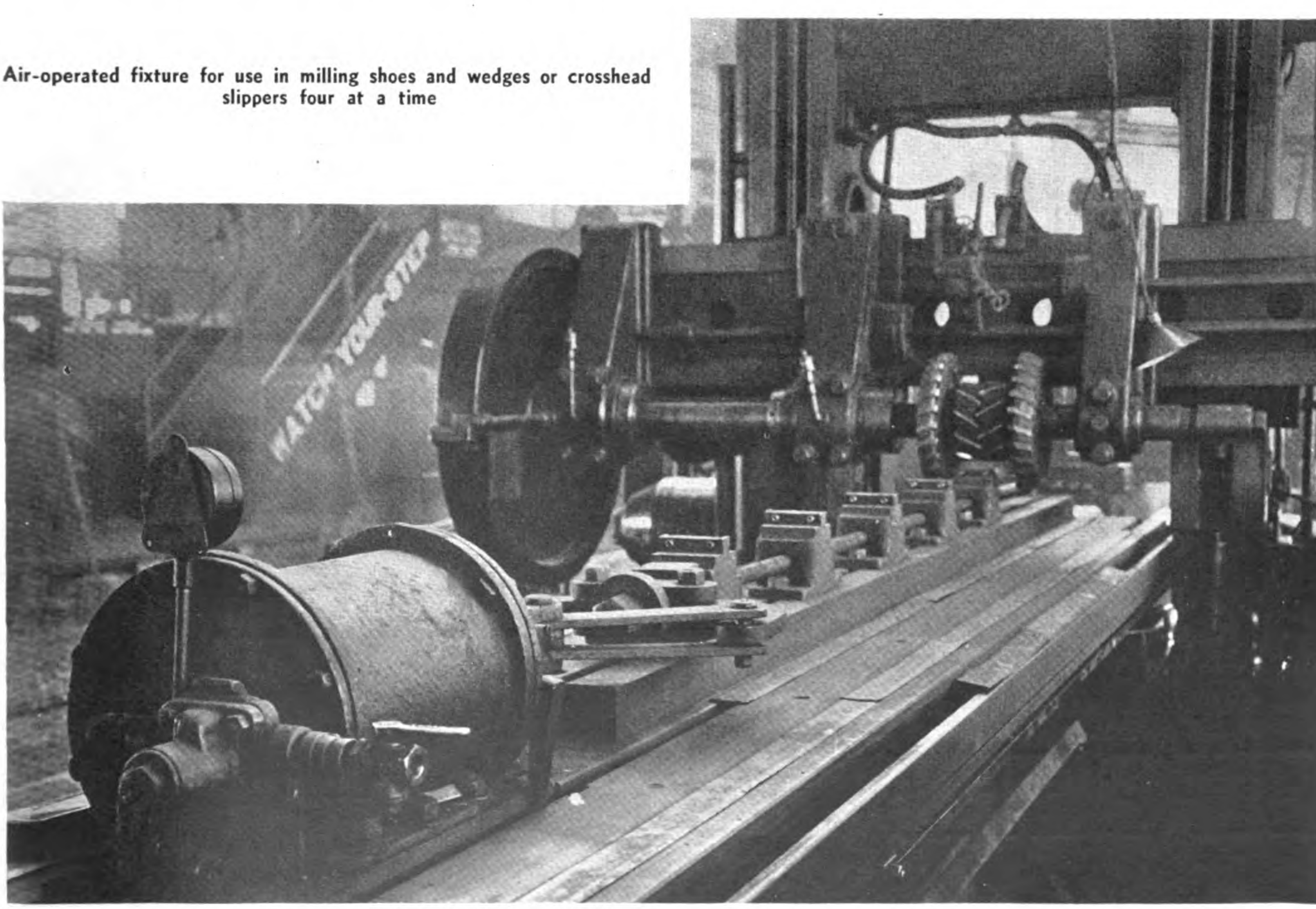
The second illustration shows a commonly used but extremely rugged and satisfactory hold-down device for use in clamping tires to the boring mill table when turning the inside diameter to fit the wheel center. The



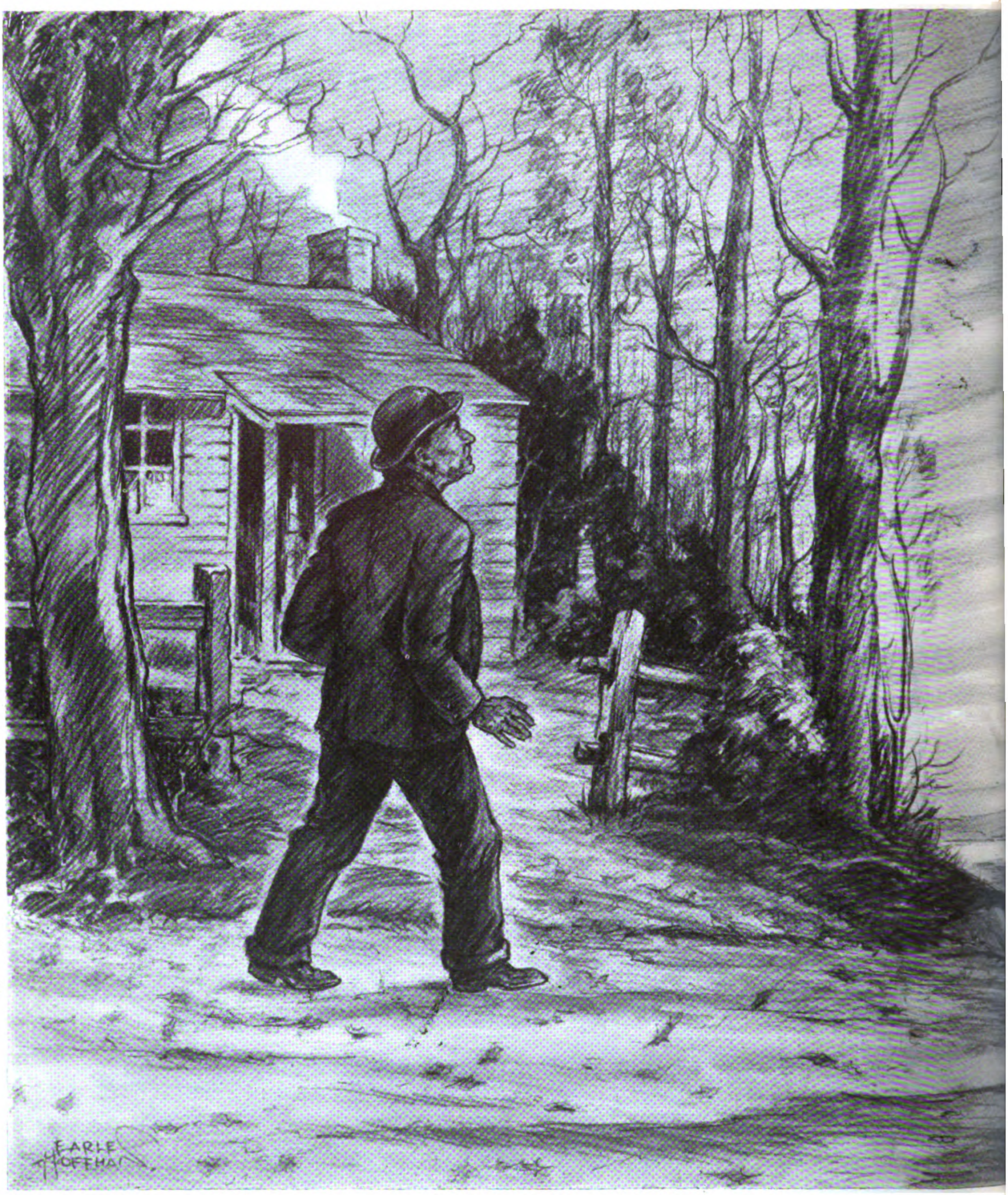
Hold-down device and cutting tool used in boring a heat-treated driving-wheel tire

hold-down device consists simply of a heavy forging hinged so that it can be swung out of the way when applying or removing the tire, and provided with a

(*Continued on page 450*)

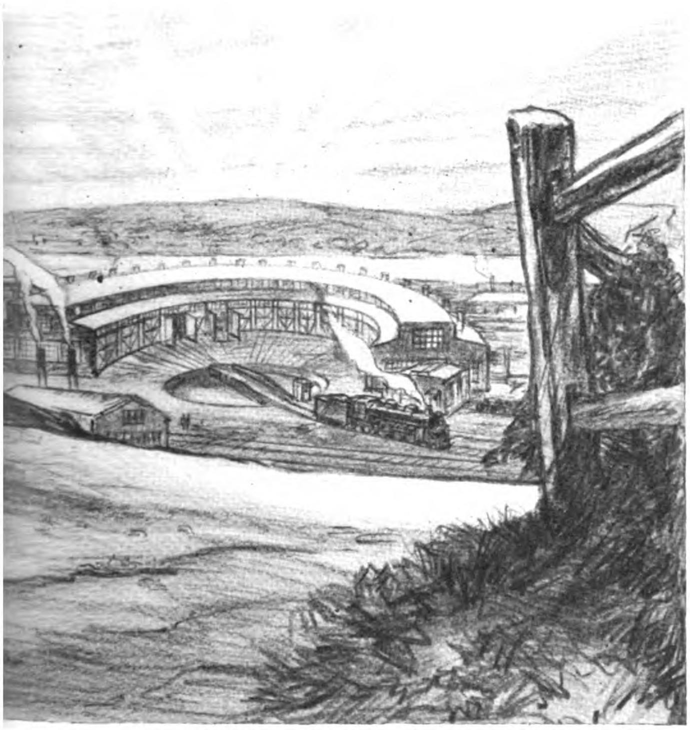


Air-operated fixture for use in milling shoes and wedges or crosshead slippers four at a time



"Guess it's about time to start getting the snow plow ready and cab curtains repaired," Evans told himself.

ZIPPERS Would Save Time



by

Walt Wyre

If an efficiency expert could have seen Jim Evans leaving home to go to work, he would have rated the roundhouse foreman one hundred per cent plus. Evans put on his hat, kissed his wife, opened the door, took a chew of "horseshoe," and was on his way to the roundhouse all in less time than advertised experts can roll a cigarette.

Evans shivered slightly. The crisp, cool air that met him was like opening the door of an over-cooled air-conditioned car on a hot day. Overhead a flock of honking geese were off to an early start on their way to the south for the winter. Like most tourists, when the time came to go, they were impatient to be on their way.

The foreman heard the honking and scanned the skies overhead, but only after several moments was he able to locate the flying wedge of geese in the gray light of early morning.

"Guess it's about time to start getting the snow plow ready and cab curtains repaired," Evans told himself.

Some one else must have seen a flock of migrating geese or else looked at the calendar, for there was a traingram on the foreman's desk instructing him to have the rotary snow plow made ready for service and see that cab curtains were in condition. The foreman laid the message in a basket on his desk and looked over the rest of the mail. There was a letter from the master mechanic commenting rather caustically on engine performance and another suggesting that he, the master mechanic, was getting tired of telling the foreman that overtime must be reduced.

The 7:30 whistle reminded Evans that the day force would soon be ready to go to work and it was up to him to have the work lined up for them at 8:00.

"How you coming on that patch in the fire-box of the 5064?" Evans asked a pot-bellied boilermaker by the name of Barton.

"Getting along pretty well, considering," Barton replied. "I've got a little more chipping to do then I'll be ready to start driving rivets."

"When do you think you'll get it done?"

"Oh, ought to make it before noon."

After work slips were distributed, Evans went back to the office.

"Old guess-and-growl wants to speak at you," John Harris, the clerk, told the foreman.

Evans cranked the office phone three times for the dispatcher. After the second attempt, an answering tinkle acknowledged the call.

"Hello . . . Yes, this is Evans."

"We'll want engines for two stock trains east, a booster 2800 about 11:00, and a 5000 about 3:00," the dispatcher said, "and I'd appreciate kettles that'll get out of the yard without using a pusher." The Plainville yards are down hill going east.

"You tell me when and what you're going to run and we'll furnish the power!" Evans retorted. "It'll be the 2836 on the first one and probably the 5064 on the second. Let you know definitely later."

"Say, Mr. Evans, we ain't got no air."

The foreman slapped the telephone receiver on the hook and turned around. The speaker was boilermaker helper Bill Cox that helped Barton.

"What's the matter, Bill?" Evans said. "Did the

stationary fireman forget to start the compressor again?"

"No, sir," said Cox, "It's the air compressor—broke down."

EVANS snapped off a chew of "horseshoe" and headed for the stationary plant located on the other side of the roundhouse from the office. He passed through between stalls eleven and twelve where machinist Jackson was boring the cylinders on the 2870, or rather had been boring them. The boring tool was idle and so was Jackson, assisted by his helper. Evans paused. "What's the matter?" Then he remembered the boring tool operated by air and he kept on going.

"What's the matter—no air?" Evans asked the stationary fireman.

"Compressor broke down. You know it's been giving trouble a long time," the stationary fireman reminded. "It might have been a good one when George Westinghouse was making his first experiments, but it's as out of date as flour sack underwear for girls now."

"I'll get a couple of machinists on it." Evans headed back so fast that he almost spit in his own face.

Five minutes later the foreman returned with two nut splitters, followed by two helpers, each carrying an armful of tools. The machinists tore into the air compressor like a Scotchman looking for a favorite dime.

"Well, it looks like the air compressor will be out of commission a couple of days," Evans remarked. "Guess we'd better set up a locomotive compressor. Fix it up like you did last time and get it done soon as you can," he told the machinists.

Evans went back to the roundhouse to see how things were stacking up there. He met the clerk at the board.

"Dispatcher wants to know what engine for the second stock train," Harris told him.

"I'll let him know in a few minutes."

Evans went down to the 5064 to see how Barton was getting along. Barton was doing his best using a hand chisel and hammer, but his best was like "the cat ate the grindstone"—a little slow.

"How you coming?" Evans stuck his head in the fire door and yelled.

"Not too good," Barton replied. "Soon as I get this chipped out I'll be ready to weld the patch, then drive the rivets."

Evans reflectively rolled his chew of "horseshoe" over with his tongue. "Better work noon hour if you have to to get it done."

"We'll have to have a pair of trailer wheels for the 5081." Evans, climbing down from the cab of the 5064, looked over his left shoulder to see machinist Barnes leaning against a column waiting for the foreman. "The journal is cut," Barnes said, "pretty bad."

"Well, go ahead and put in a pair," the foreman said a little testily.

"There ain't any 5000 trailer wheels."

"Sure?"

"Yep; I looked all over and then asked the storekeeper—asked him twice. He's said 'haven't got it' so much it's a habit and I asked the second time to be certain he knew what he was talking about."

"All right"—Evans took a fresh chew—"get a pair off the 5072. She's tied up waiting for a set of tires. I'll go see the storekeeper."

"How about trailer wheels for 5000's?" the foreman asked the storekeeper. "Got any ordered?"

"Yeah; ought to be in next week. We got four pairs for 2500's," the storekeeper added.

"I'm not interested in 2500's," Evans said sharply. "They've all been sent away except one and it's leaving this week, soon as the 2842 gets back from the shop."

"Jumping Caesar!" the storekeeper ejaculated, "and we've got a bunch of supplies for 2500's coming in the next car."

"What is it?—bananas?" Evans chuckled. "That's the only thing I can imagine the store department getting in bunches."

"If the mechanical department would let us know what kind of material was going to be needed, and when, we might be able to keep supplies," the storekeeper retorted. "Look at that stuff for 2500's! Two handlings on all of it and none used."

"Rush them on them trailer wheels," Evans replied as he started back to the roundhouse. He knew that the storekeeper was partly right in what he said. No small part of the material shortage could be laid at the door of the mechanical department for not letting their material requirements be known in advance.

"The dispatcher is having conniptions," the clerk said when he had found the foreman. "He's called three times wanting to know about the stock train engine."

"Tell him the 5064." Evans drowned a bug with a sluice of tobacco juice. "What time does he want it?"

"Three-fifteen," the clerk replied.

"I hope he gets it," the foreman said in the same tone a theater patron uses when expressing a desire to win the money on Bank Night. "Tell him we'll do the best we can. The air compressor broke down and delayed things."

Evans stopped at the drop-pit to see how the dead work gang was getting along with the 5097. He had told the master mechanic that the engine would be ready to go in a couple of days. The foreman brightened up when he saw how work was progressing on the classified repairs. The engine was wheeled and machinists were ready to start putting up the rods. With any luck at all, she'd be ready for a fire by noon next day. Then wouldn't the master mechanic be surprised!

EVANS went the the office in right good humor. He looked at his watch—11:10. A muffled rat-tat-tat told that the emergency air compressor was working and so were the boilermakers. Perhaps there wouldn't be any delay on the stock train after all.

The foreman leaned back in his chair and propped his feet on an open drawer of the desk. He was resting easy figuring what bait to use that might land the big trout that got away two weeks before. The next Sunday was his day off and he was going to have one last try for the speckled beauty before the season closed. He had just about decided on using a gray hackle with a yellow body on a number six hook when the engine inspector came in.

"Right crosshead broken on the 5085," the inspector announced.

The trout got away again, mentally, at least. "Tell the hostler to get the engine in the house soon as possible so we can get to work on her. We've got to use her tonight on No. 10." Evans followed the inspector out to the inspection pit.

The crosshead was broken and would have to be replaced. No doubt about that. The foreman headed for the roundhouse like he was going to a fire. He found machinist Jenkins and told him to caliper the guides on the right side of the 5085 so that the machine man could start planing a crosshead without delay.

When Evans returned from lunch, he went to the roundhouse first thing to see how the 5064 was getting along. It wasn't so bad. Barton had finished the patch and the boiler was being filled. The fire-builder was waiting to start a fire in her the moment water showed in the gage glass. "Give her all she'll stand," Evans

told the fire-builder and went down to the 5085 just as the 1:00 whistle blew.

"Did you get Harrison lined up to start right in on the crosshead?" Evans asked Jenkins.

"There wasn't any crosshead in the storeroom," the machinist said. "That is, there wasn't one that'll fit a 5000."

The foreman spat out his chew of "horseshoe" as though it had sand in it. He walked away four or five steps and turned and came back. He stood for a moment, brows puckered, eyes half closed, and absent-mindedly felt for his plug of horseshoe.

Still thinking of the crosshead, Evans bit down on what he thought was chewing tobacco. The tobacco seemed tough. He bit harder. Then he discovered that he was trying to bite a corner off a hunk of asbestos packing, a sample handed him by a supply salesman the day before. He swore and threw the sample of packing away.

"Dammit—guess we'll have to rob one off the 5097." Evans found his plug of "horseshoe" and examined it carefully before biting off a hunk about the size of an old style three-quarter nut.

Gone were the chances of getting the 5085 out the next day. The best that could be done would be three or four days getting a crosshead, then the storekeeper would have to wire for it and have it shipped passenger. The management didn't approve of shipping heavy parts by passenger, either.

The second stock train got out almost on time. It was called for 3:20 and got out at 3:30. The ten minutes were lost making up the train. No use telling that the engine wasn't ready either.

Engineman Foster came in on the stock train. Evans was in the office when the engineer came in to make out his report.

"Say, that reverse gear on the 5066 that I came in on. It's in bad shape," the hoghead said.

"What seems to be ailing it?" the foreman inquired.

"Creeping; it won't hold anywhere. I reported it last trip and it's worse now. It came pretty near working in reverse just this side of Middleton. Mighta tore something up if it had. Better fix it," Foster advised.

"O.K., we'll get it," Evans replied looking out the window to see if the 5064 was about ready to get away. He couldn't tell by looking and went out to see. Just as he left the office the engine pulled out.

The foreman went on to the roundhouse. "How you coming on that crosshead? Got it off yet?" he asked machinist Jenkins.

"Oh, yeah. It's in the babbitt shop. The coppersmiths are getting ready to pour it now, I think."

"Getting ready to pour it?"

"The guides on the 5085, they're a little narrower than the ones on the 5097. The crosshead will have to be babbitted and planed to fit."

"Now ain't that nice!" Evans said in a tone that meant it wasn't nice at all.

Trying to explain overtime with prospects of more overtime piling up to be explained is never very nice, particularly with a master mechanic like H. H. Carter that doesn't care much for explanations unless preceded by the desired results.

Evans figured mentally a moment, then walked away. There was nothing to be done about it. The Limited had to run. It couldn't run without a locomotive. The only locomotive available was the 5085. The locomotive couldn't run without a crosshead. The only crosshead available wouldn't fit without babbitting and planing. Then it had to be put on. Just like a geometry problem solved by axioms, and it had two answers. One was overtime. The other—the 5097 wouldn't get out the next day as expected and it would be up to Evans to explain both.

"Well, tell them to rush work on the crosshead much as possible and you and your helper work overtime to put it up, and while you are waiting, take a look at the reverse gear on the 5066. The engineman that came in on it reported it leaking bad."

The machinist gathered up some tools and started down to the 5066. The engine had been put in the house in stall twelve. Evans took a turn through the roundhouse to see how things were getting along and went back to the office hoping to get a few moments rest before five o'clock came.

A second time for the day he got comfortably seated in his favorite position. Things weren't going any too good, but worrying wouldn't help. Again he thought of the big rainbow trout that two weeks before had struck short and turned up his nose at every tempting bit of fluff, feather, hair, or tin that had been offered in various combinations.

"Perhaps a plain coachman fly with a spinner ahead of it would do the trick, or maybe a shimmy wiggler," Evans was debating lazily in his mind.

"Leather's worn out in the reverse gear of the 5066." It was machinist Jenkins.

"Tell Martin and his helper to put in a new one. You better get back to that crosshead. I want to get it soon as possible." Evans again relaxed to his mental battle with the wiley trout. He was just about to land the poor fish on a medium sized spoon when Machinist Martin came in.

"They haven't got any leathers for the reverse gear in the storeroom," the nut splitter informed the foreman. "What'll I do about it?"

"Rob one off the 5097," Evans said wearily. "It's getting to the point that an engine on the drop-pit is not there to be repaired; it's there to be robbed."

"Want me to finish it?" Martin asked.

"No-o—let the night men get it if they have to run the engine tonight."

"O.K." The machinist turned and started back to the roundhouse.

The phone rattled sharply. John Harris lifted the receiver. "Yes, clerk talking . . . Don't know. I'll ask him." Harris turned to the foreman. "The dispatcher says there'll be two sections of the Limited tonight and wants to know what engines you're going to give him. What'll I tell him for the second one?"

"Tell him the 5066," the foreman answered as he went out the door to catch Machinist Martin and tell him to work overtime on the engine.

Time passed on, ten days of it. Evans didn't catch the big trout, but, by golly! he'd get him the first Sunday he had off when the season opened next Spring, even if he had to use worms or grasshoppers.

One morning Evans went through his usual ritual of putting on his hat, kissing his wife, opening the door, and taking a chew of "horseshoe." When he opened the door a gust of cold air slapped him in the face and settled a whirling snow flake on his nose. "Where's my sweater?" he asked his wife.

"Right here on a chair. Thought you might need it today and got it out last night," his wife replied.

When Evans reached the office he found the message he was expecting, wanting to know if the snow plow was in shape for service and cab curtains in good condition.

"Get the snow plow in the house first thing," the foreman told the hostler.

Soon as the eight o'clock whistle blew, Evans told the

cab carpenter to get busy putting on cab curtains and coopering cabs. He told the machinist assigned to the rotary snow plow to look it over and test it out.

While Evans was talking to the machinist, the cab carpenter returned from the storeroom. "There's not any cab curtains in the storeroom," the carpenter said.

"Well, tell the storekeeper to wire for them and get them soon as possible."

About three o'clock in the afternoon the machinist that was looking over the snow plow came to the office. "There's not any dynamo on the snow plow and several valves are missing—been robbed," the machinist said.

"Now what the hell! Where's the dynamo?" Then Evans remembered. It had been taken off to put on a pile driver early in the summer. No chance of one in the storeroom. "Tell the electrician to get one off the 5092. She'll be tied up on the drop-pit several days, and tell the coppersmith to get the valves replaced."

"What do you mean most of our overtime is because of lack of material, then say it's partly our fault?" the master mechanic asked Evans a few days later.

Evans shifted his chew of "horseshoe." "Well, robbing dead engines of parts necessary to keep live engines going accounts for a lot of wasted time and——"

"Wouldn't have to do it if the storeroom had the parts," the master mechanic interrupted.

"That's true," Evans replied, "but maybe if we'd be a little more careful about ordering stuff we don't use and work with the store department a little better they'd keep stuff we do need."

"Perhaps. But anyway, overtime must be cut out." Carter left with the ultimatum.

Battle Creek Shop Kinks

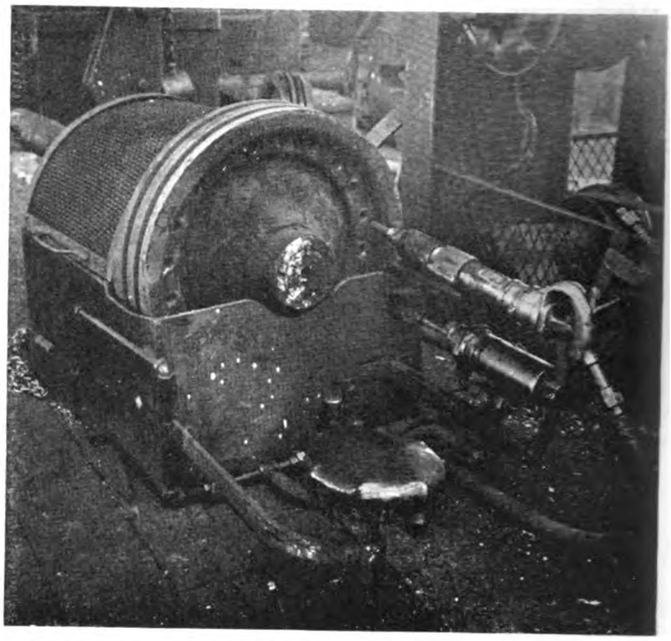
(*Continued from page 445*)

knurled and hardened eccentric wheel which contacts the upper surface of the tire and tightens under the pulling action of the cut. The tire illustrated is a 73-in. heat-treated tire which presents some difficulties in machining unless a powerful and accurate boring mill is used and a cutting tool which will stand up to this heavy duty. Roughing cuts are taken with a special form of cutting tool, made of Rex AA steel, the cutting speed being 20 ft. per minute and the feed $\frac{7}{32}$-in.

Some difficulty is experienced in taking the light finishing cuts on these heat-treated tires and this problem has been solved at the Battle Creek shops by the unusual expedient of speeding up the work to about 200 ft. per minute and using a $\frac{1}{64}$-in. feed. This gives a finish which looks almost as smooth and accurate as grinding. The first part of the cut, shown in the illustration, is being made at this high rate of speed and low feed, with a sharp-pointed carbide alloy cutting tool.

The third illustration shows an unusually convenient and effective device for removing the rivets from composite pistons built up of cast-steel centers and separate bull rings. The device consists simply of a sheet-metal housing around a double pair of rolls (old headlight generator ball bearings) arranged to support the piston rod and piston in such a way that they can be conveniently revolved. The end plate of the housing carries a small air cylinder and a lever arm device for supporting the pneumatic hammer used in backing out the rivets.

In using this device, the rivet heads are first burned off with an acetylene cutting torch; the air hammer is centered against one of the rivets; air pressure is applied to the small intermediate cylinder, bringing the punch tightly against the rivet; the pneumatic hammer is operated and the small cylinder moves the hammer forward, as rapid repetitive blows from the punch force the rivet back out of the hole. The machine is operated by one man and it will be noted that a small but convenient seat is provided, as the operator would otherwise have to bend over low or kneel on the floor.



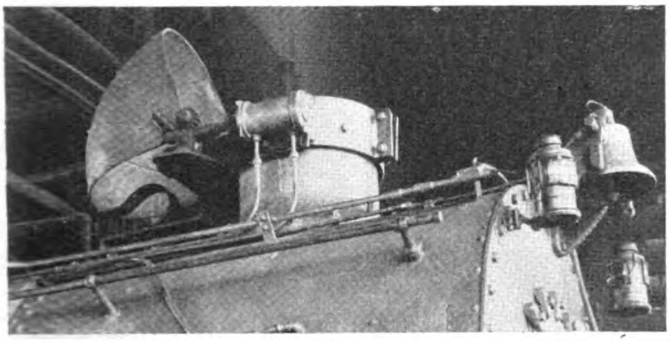
Convenient and safe air-operated device for backing out piston bullring rivets

After removing one rivet, all that the operator has to do is to release the air in the small cylinder, pull back the pneumatic hammer, turn the piston to the proper position and he is ready for the next one. As a safety measure, a substantial wire mesh screen is provided over the back of the device to catch all rivets and prevent any possibility of their flying out and causing personal injuries.

ACCURATE MEASURING—The following is vouched for by a division superintendent of the Atchison, Topeka & Santa Fe: The division on which he was at the time this happened was handling a heavy traffic, and in response to a call for additional power a number of Santa Fe type locomotives were transferred from another division. These locomotives, having small diameter drive wheels, were bulletined to travel at a rather limited speed. Shortly after these locomotives were put on the division, the roadmaster reported a bunch of badly kinked rails in a sag where it was found that one of these locomotives had been operated considerably in excess of the speed limit. The superintendent questioned the engine crews that had been on all of these locomotives and all of them denied having exceeded the speed limit. What to do? He thought it over a couple of days and finally had a happy thought. He asked the division engineer to send a couple of men out to measure the circumference of the main drivers on each of these locomotives as accurately as it was possible to do so, and as luck would have it, he found that there was an appreciable difference—in fact, as much as seven inches in the circumference of these drivers due to the difference in tire wear. He then sent these engineers out on the field to measure the distance between the kinks in the track, measuring the distance over a considerable distance so as to strike an average, and found that these kinks fitted the circumference of only one of the locomotives. Upon being questioned, the engine crew of that locomotive admitted that they had been running pretty fast at the point in question.

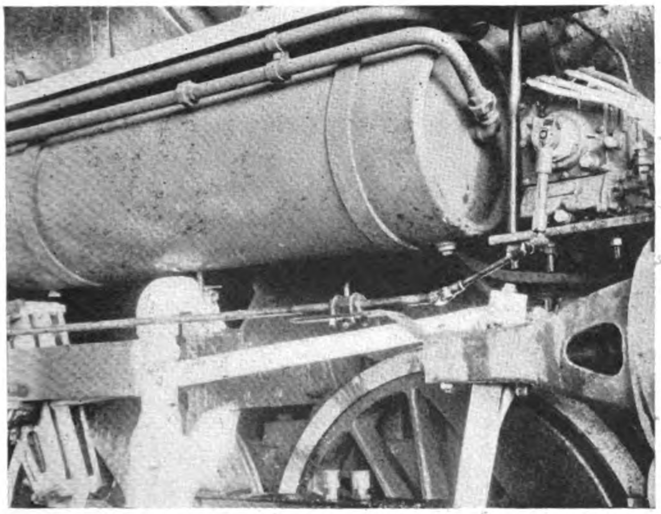
Locomotive Devices Used In Mountainous Country

The two illustrations accompanying this article were taken at the Denver, Colo., enginehouse of the Denver & Rio Grande Western and show two devices, the value of which has been demonstrated by experience on a railroad which passes through more or less mountainous country and encounters some heavy grades and occasional tunnels.



Type of smoke deflector used on D. & R. G. W. locomotives which operate through tunnels

In the first illustration, the smokestack is shown equipped with a heavy steel band clamped on the top and arranged to support a 90-deg. section of sheet metal elbow or hood which may be rotated so as to cover the stack opening when passing through a tunnel and deflect the smoke backwards over the locomotive and cab, thus making it possible to maintain more satisfactory atmospheric conditions within the cab itself. The hood, pivoted on a 1-in. bearing shaft back of the stack, is operated by means of a small air cylinder with rack and pinion connection to the hood and operated by an air control valve in the cab. A substantial flat spring, shown in the illustration, serves to cushion the fall of the hood when it drops into the unused position and also provides a stop against which the hood rests when not in use.



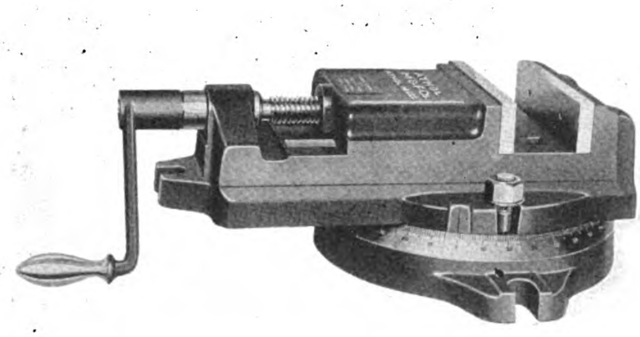
Detroit lubricator with driving arm which is automatically lengthened so as to deliver less oil when drifting

Another interesting feature of this locomotive, noticeable from the illustration, is the fact that the front cylinder and valve chamber head covers, instead of being made of pressed steel with rounded corners, are evidently fabricated from flat circular steel plates to which steel bands of the proper width are welded to form the covers. The second illustration shows a D. & R. G. W. locomotive equipped with a new Detroit mechanical lubricator driven through a suitable mechanical connection to the valve gear link. It will be noted that the horizontal driving bar or rod is well supported and guided. The swinging drive rod on the lubricator itself is designed with a spring-controlled extension which permits lengthening the rod approximately 4 in. and decreasing the amount of oil delivered to the valve chambers and cylinders when the locomotive is drifting. Just as soon as it is necessary for the locomotive to work steam, this drive rod is shortened again, the length of the stroke increased, and more oil delivered to provide adequate lubrication. On certain classes of D. & R. G. W. locomotives, lengthening and shortening of the lubricator arm is done automatically when the throttle is closed or opened, and in other cases the control is entirely mechanical by lever connection to a handle within easy reach of the engineman's position in the cab.

Milling Machine and Drill Press Vise

A milling machine vise with an easily removable swivel-indexing base, announced by Athol Machine & Foundry Company, Athol, Mass., provides for an unusually wide range of general machine shop uses. Used with the indexing base, milling machine and other operations requiring accurate angle settings are easily and conveniently handled. Removed from the swivel base, the vise is ideally adapted to drill-press and many other types of use.

The indexing base is graduated over 180 deg., extending 90 deg. each way from zero. Two clamp bolts hold the vise bed in position on the swivel base. The vise base, bed and jaws are semi-steel castings of generous proportions. Jaw facings, of hardened tool steel, are removable. Inexpensive false jaws may be provided, shaped to hold any shaped piece. The vise screw has the Athol buttress thread, 50 per cent heavier at the root than a square thread of the same pitch. The extra metal and extra strength come just where the strain is greatest. An extra heavy shoulder is an integral part of the vise screw. The crank handle is long enough for ample leverage, and is removable.



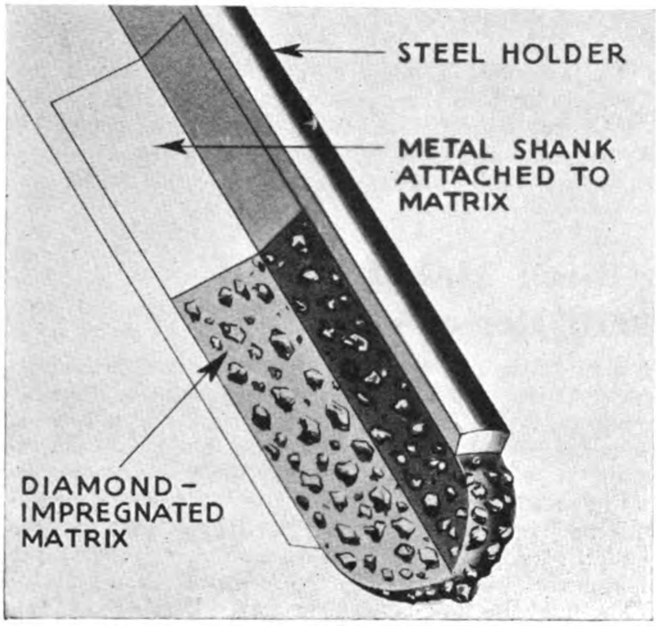
Athol milling machine vise with easily removable swivel-indexing base

The swivel-base milling machine vise is available in two sizes, with 4-in. jaws and with 6-in. jaws. No. 1024, with 4-in. jaws, has a depth of jaw of 1⅜ in., opens 3⅛ in. and weighs 45 lb. No. 1026, with 6-in.

jaws, has a depth of jaw of 1⅝ in., opens 4 in. and weighs 70 lb. Either model is available without the swivel base for use exclusively as a drill press vise, if preferred.

Diamond-Impregnated Wheel Dresser

The Carboloy Company, Inc., Detroit, Mich., has added to its line of Carboloy cemented-carbide products a diamond-impregnated wheel dresser. The new grade contains an extra coarse mesh of diamonds and has been developed to increase the order of performance on the larger and harder grades of grinding wheels used on surface, cylindrical and centerless grinders. This extra coarse grade supplements the existing grades of Carboloy dressers containing fine, medium and coarse mesh size diamonds. With this development, the Carboloy dresser is available for all hardnesses and sizes of grinding wheels.



Carboloy diamond impregnated wheel dresser

Advantages of the Carboloy diamond-impregnated wheel dresser, as claimed by the manufacturer, are that no remountings are required, they stand unusual abuse, and each dresser may be used throughout its entire life on the same size wheel.

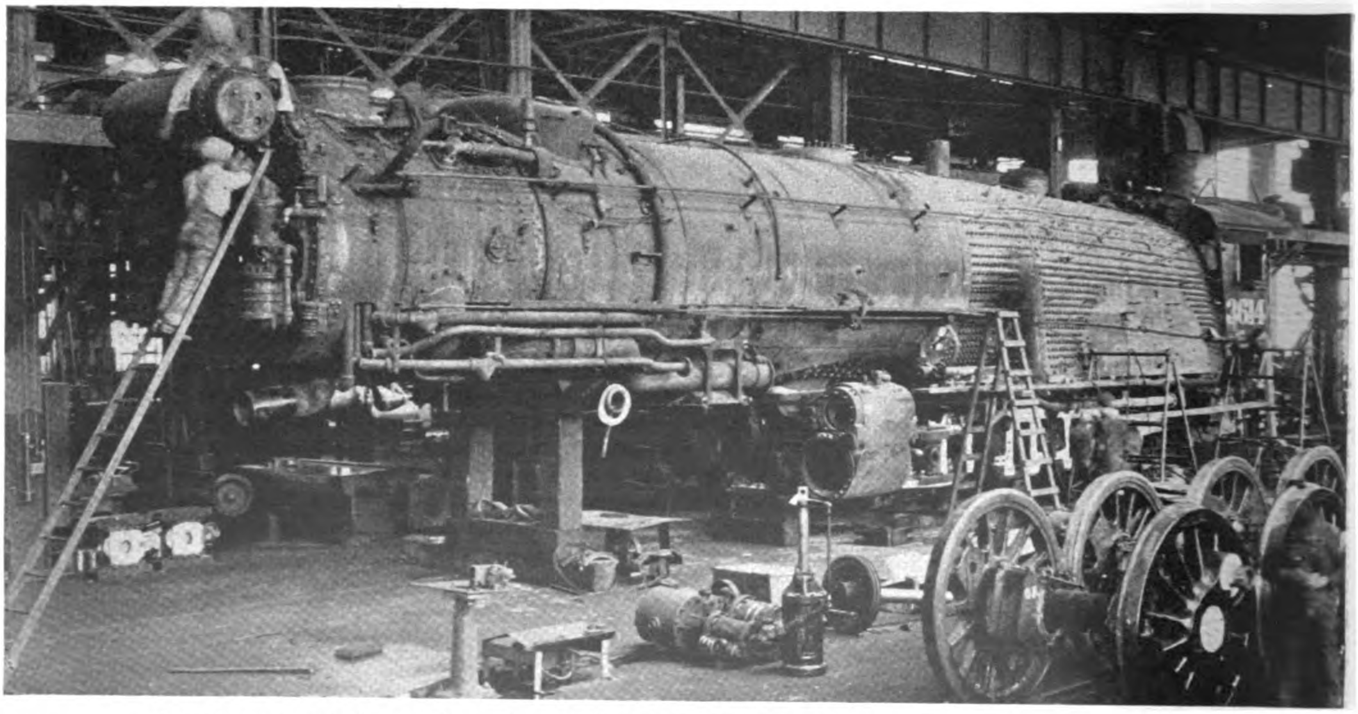
Ideal Electric Marker

The Ideal electric marker, a small portable tool for marking on practically any material, whether metal, or non-conductor, is announced by the Ideal Commutator Dresser Company, 1561 Park avenue, Sycamore, Ill. Legible and permanent records can be made on all metals and their alloys; on dies, tools, plates, sheets, shapes, rods, forgings, castings, pipes, equipment; and also on glass, pottery, ceramics, hard rubber, bakelite, plastics, fibre and similar materials.

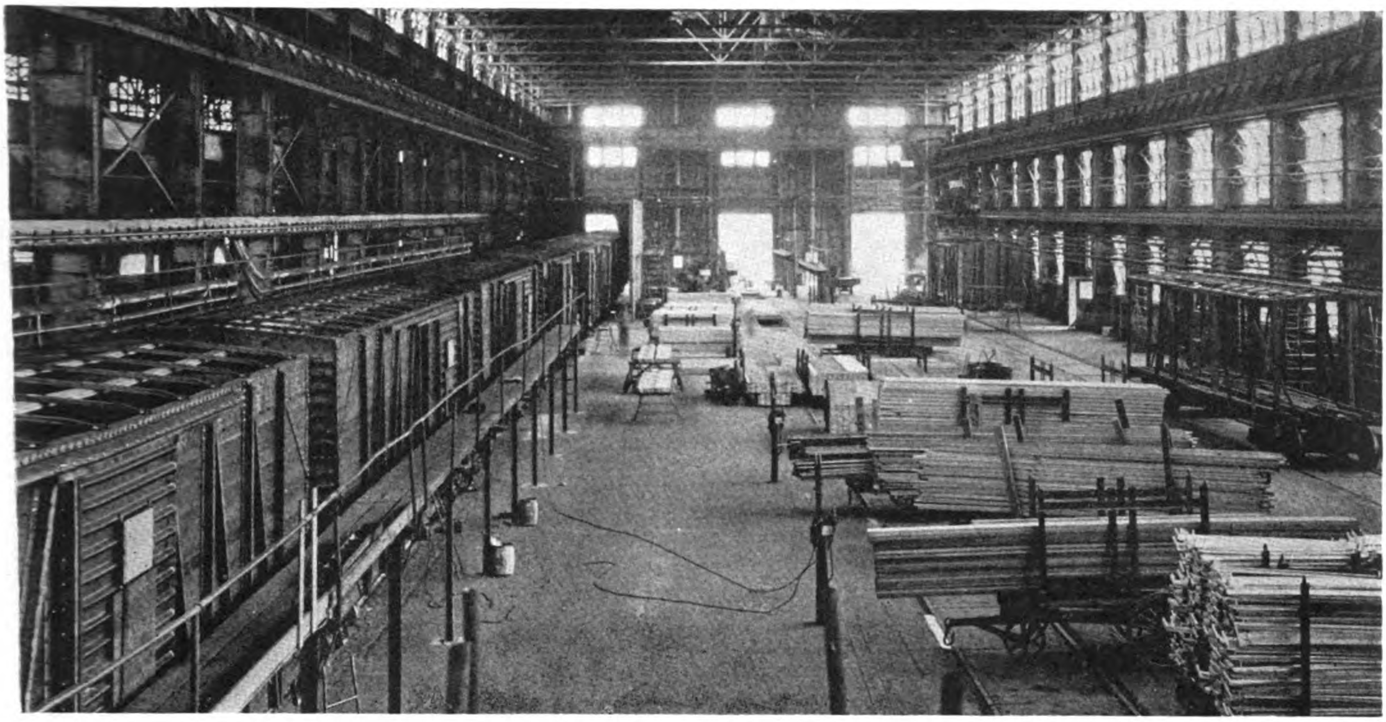
The instrument is 6¾-in. long, weighs 2 lb., and is handled similarly to a pencil or crayon. It operates on the principle of a miniature hammer at the rate of 3,600 strokes per minute. It requires no cabinet, auxiliary controls, rheostats or transformer for operation. The point does not stick into the marking surface. It makes permanent lines, cut into the surface, that cannot be removed by ordinary wear and tear of handling.

The marker operates on 110 volt 60 cycle alternating current, and consumes approximately 75 watts. It can, also, be furnished for other standard voltages and frequencies. The unit has a 6-ft. cord with plug and on-off switch. Each marker is regularly supplied with a hardened point for working on all materials including hard steel or similar products.

* * * *


One of the big 2-8-8-2 type locomotives of the D. & R. G. W. undergoing heavy repairs at Denver shops

With the Car Foremen and Inspectors

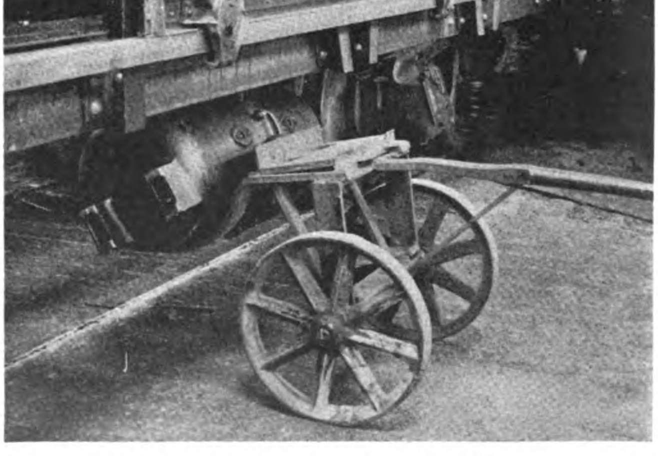


Interior of the Havelock erecting shop as equipped for heavy car building operations

Car Work at Havelock Shops

Since the concentration of all heavy locomotive repair operations on the Chicago, Burlington & Quincy at two main shop points, namely, West Burlington, Iowa, and Denver, Colo., the large shops at Havelock, Nebr., formerly devoted exclusively to locomotive work, have been re-equipped and organized to handle program car repairs and, in fact, the construction of complete new cars on a modern production basis. Machine tools, located in the machine shop and not needed for car repair work, have been, for the most part, removed and shipped to other shop points on the Burlington lines, the heavy machinery bay then being used for the storage of car materials, the fabrication of certain car parts, boring and turning car wheels, machining various castings, etc. One track, extending into the shop and through the center of the heavy machinery bay, provides a convenient means of getting car materials into the shop and the overhead crane assists greatly in unloading them.

In the erecting shop, as shown in one of the illustrations, three tracks extend into and through the shop building, the two outer tracks being normally used for the straight line car rebuilding operations, and the center track for material delivery and storage. The cranes are here used to great advantage for transferring material and also car underframes, bodies, etc., when necessary. Convenient scaffolds for both side sheathing and roof work are installed where needed, and, in general, these scaffolds are designed so as to occupy a minimum floor space, being supported on short sections of steel rail set in a concrete base in the shop floor. Another illustration gives a close-up view of one of the three oxy-acetylene stations used to distribute oxygen and acetylene gas required in the welding operations. Two of these three stations are equipped to distribute high-cycle electric power at 220 volts and 180 cycles for electrically operated floor sanders, portable handsaws, drills, etc. Both the oxygen and acetylene connections, as well as those for the high-cycle electric current, are conveniently ar-



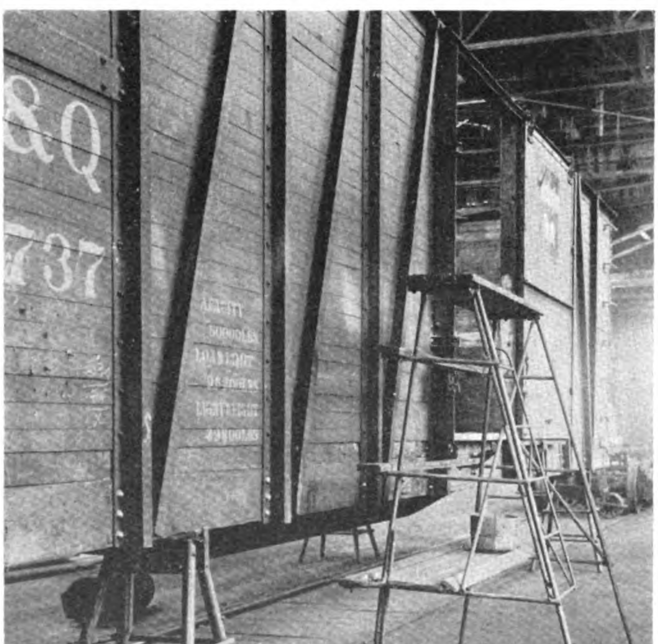
Special two-wheel truck used in applying air brake cylinders and reservoirs

The mono-rail hoist and special equipment at the truck assembly job

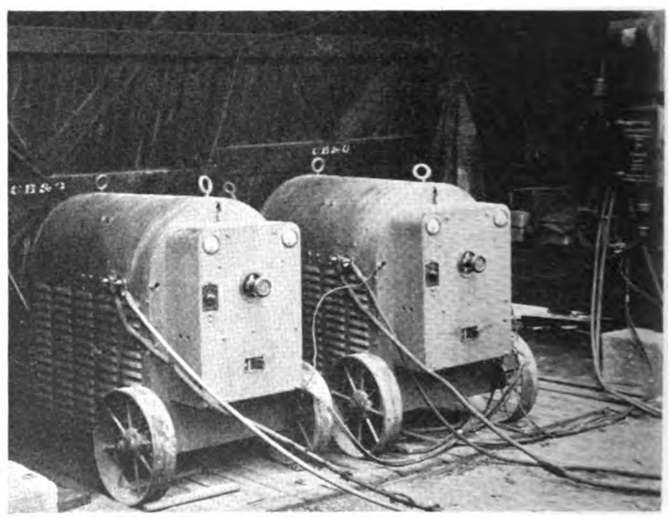
ranged on a short section of superheater flue set two feet in the shop floor.

One of the illustrations shows a two-wheel cart used in applying brake cylinders and air reservoirs underneath the cars. As shown, this cart consists of a welded steel framework mounted on two 20-in. wheels and provided with two semicircular arms on one end to support the air reservoir and a long 8-ft. handle on the other to give adequate leverage for lifting the reservoir up against the car underframe and hold it securely while being clamped and bolted in place. Incidentally, the flat section of this cart immediately above the wheels is designed to hold the triple valve while it is being moved under the car and bolted to the reservoir.

Tubular steel trestles are used for supporting car bodies with the trucks removed and also for the convenience of car men while applying and bolting siding in place. These two types of trestles are clearly shown in

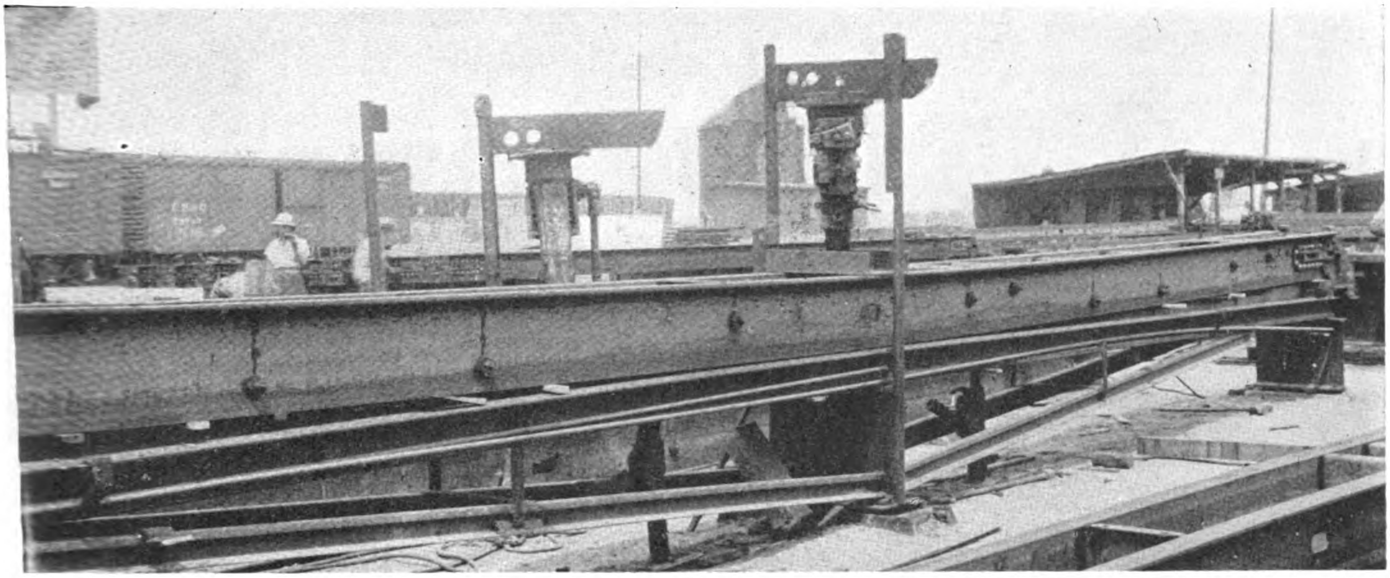


Light but strong welded tubular-steel trestles used as car supports and for workmen to stand on while bolting car siding



Two Westinghouse 600-amp. welding machines used in furnishing current for the multitudinous welding operations at Havelock shops

one of the illustrations, the first consisting of a light but strong welded tubular-steel framework 42 in. high, made of 1½-in. double-strength pipe corner posts, held together by horizontal side braces, made of ¾-in. pipe electric-welded at the corners. The top of the trestle consists of a 5-in. I-beam rigidly held in place by electric welding. Short metal retaining straps, welded to the ends of the channel, serve to help position the thin hardwood block which is placed on top of the channel and supports the car weight. This type of car-supporting trestle combines great strength with light-weight and ease of handling. As an unusually severe test, and to make sure that this trestle could be used safely, it was applied under a car body loaded with 40 to 50 tons of scrap car wheels



Jig used for giving the proper camber to center sills before they are welded

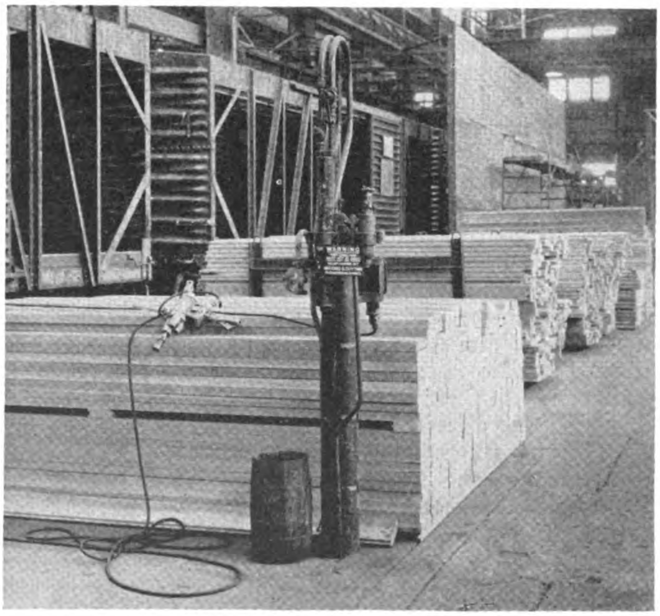
and withstood this load safely with no evidence of bending of the trestle tubes or rupture of the welds.

The siding trestle is 8 ft. high and 6 ft. long, the main A-frame members being made of ¾-in. pipe braced with ½-in. pipe and having ladder steps made of ⅜-in. pipe, this structure being completely fabricated by electric welding. The trestle is stiffened by ½-in. cross brace pipes securely welded in place, as illustrated. The horizontal pipe sections are extended slightly beyond the A-frame toward the car to provide support for narrow wood footrests. The top step is a 1¼-in. plank, 10 in. wide by 6 ft. long. This trestle is amply strong and rigid to provide a firm support and footing for car men while working on the side of the car. Referring to the illustration, it will be noted that short pieces of 1 in. by ⅛ in. steel, bent in the form of an arc, are welded to the bottoms of the trestle legs. These are applied so that one man can lift one side of the trestle and readily pull it along the shop floor to whatever position may be desired for the most convenient handling of his work.

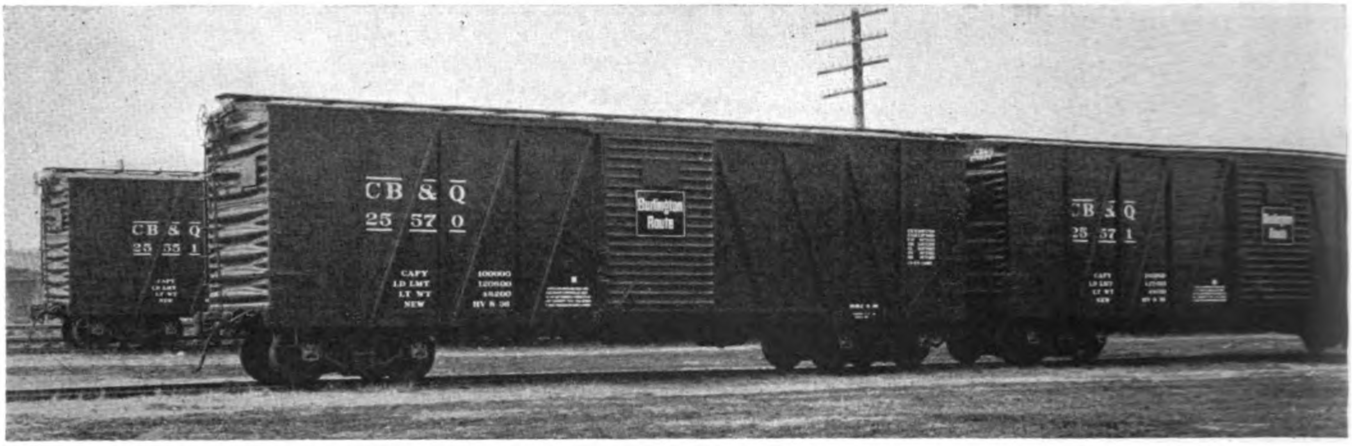
Jig for assembling roof carlines and purlines prior to bolting and application as a single unit to the car frame

Another illustration shows a special jig for assembling carlines, purlines and the ridge pole of the car roof which is applied as a unit to the car, using either the shop crane, or a locomotive crane if the work is being done outside the shop building. This jig is made of scrap angle irons and trainline pipe, welded together and having the legs of the proper length so that the jig will be at the elevation needed for easy working. Twenty-six rivets, spaced on the same centers as the carlines, are welded to the upper side of the angle irons and serve to position the carlines and purlines while they are being assembled to form the frame of the car roof. The bolting and welding operations are then completed and the entire roof is applied to the car as a unit.

An unusually interesting method of providing the proper camber in center sills used in these cars is shown in one of the illustrations. The new A.A.R. type of center sill is used, consisting of two Z-sections which are welded together along the top center lines while still in the camber jig. This jig is made of two 90 lb. rails supported at the ends on short sections of heavy I-beam bolted to a concrete foundation, these rails being bowed at the center 2½-in. by means of 90 lb. steel rail truss rods, as shown in the illustration. The purpose of this construction is simply to provide a long, stiff and rigid foundation on which the center sill sections may be



One of the oxy-acetylene and high-frequency electric power stations in the erecting shop



Partial view of two strings of 50-ton single-sheathed box cars recently built at the Havelock shops of the C. B. & Q.

placed in an inverted position, blocked up at the ends and jacked down at the middle to give the desired camber. The 75-ton jack is supported in an inverted position by having its base welded to a 22-in. by 10-in. by ¾-in. steel plate arranged to swivel on a 1 ¼-in. vertical pipe section on one side of the jig and be locked under a suitable lug on the other vertical pipe. This permits swinging the jack out of the way when inserting or removing the center sill sections. While two jacks are shown in the illustration, only one per jig is used, the jack at the left being installed on a second cambering machine.

Welding the Center Sills

In operation, the center sill Z-sections are bolted together and fitted up as much as practicable before the welding operation and applied in the device. The ends are blocked up, the jack swung into place and the ram brought to bear against a short channel section which rests on the two center sill sections. The jack is then operated to deflect the center sills 2 ¼ in. which has been found by experience to be enough to give about ⅜ in. permanent camber after the welding operation. In welding, the joint between the two sill sections is backed up by a copper strip underneath which gives a smooth finish to the under side of the sill weld. The weld is made by two operators using the skip method, with 6-in. welded sections separated by 4-in. spaces. From the bolster to the ends, the sill sections are welded together complete, so that approximately 75 per cent of the entire length of the sill is welded. Coated welding rod ⅜ in. in size is used for the most part for this welding operation. The two 600-amp. welding machines which furnish current for the extensive welding operations at Havelock shops are of Westinghouse design and were secured from the Denver shops.

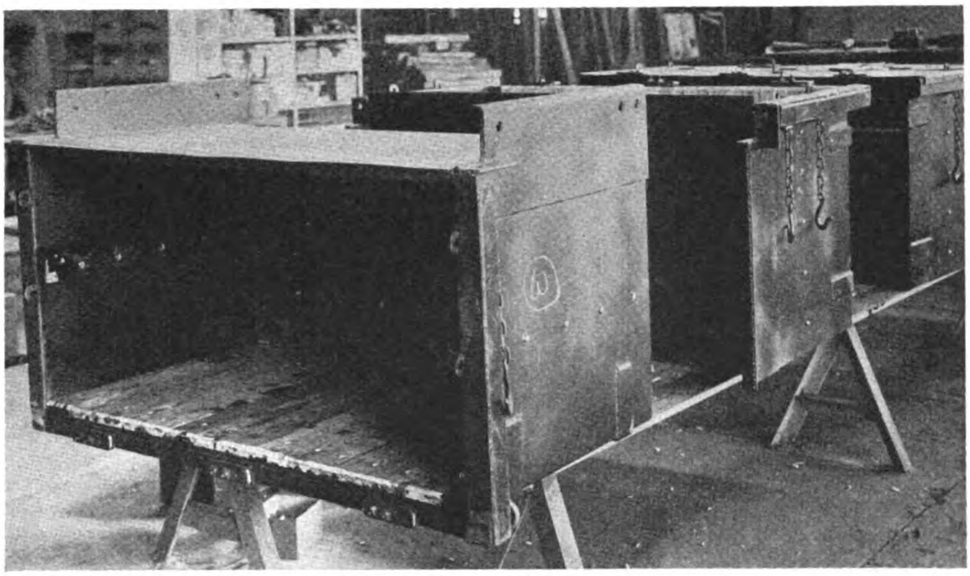
There is nothing particularly novel about the truck-building operations at Havelock, but this work is efficiently organized and carefully done in accordance with the best recommended practice. The truck work is performed outside of the shop underneath a fixed mono-rail equipped with three movable 5-ton chain falls, as shown in one of the illustrations. This mono-rail is made of a scrap center sill channel supported about 24 ft. high and transverse of the track by means of well-braced and strong wooden side frames. The ends of the mono-rail extend about 10 ft. beyond the supporting uprights and are provided with stops in the interests of safety. The outside chain falls may therefore be used for lifting side frames at either side of the station and bring them into the truck position while the center chain falls are used to lift the bolster. With this device, truck side frames, bolster wheels and all other parts may be assembled with minimum hand labor and lifting; and, moreover, with reasonable care, there is little danger of damaged journals or personal injuries.

Electric Welding at the Beech Grove Coach Shop

As in other shops throughout the country electric welding is extensively used at the Beech Grove, Ind., shops of the Big Four to expedite car repairs and save both material and labor in many individual repair operations.

In the construction of battery boxes, for example, a saving of approximately 50 lb. weight per box is effected without any sacrifice of strength. The general design of the boxes is evident from the illustration which shows four boxes in various stages of construction. Made of No. 10 gage steel, the various sheets and angles used in the box are assembled in position in a special jig and arc-welded together. The outside seams are welded, using No. 7 ⅛-in. coated wire, and then the insides, using No. 5 $\frac{5}{32}$-in. wire, to speed

Passenger car steps fabricated by a combination of riveting and welding

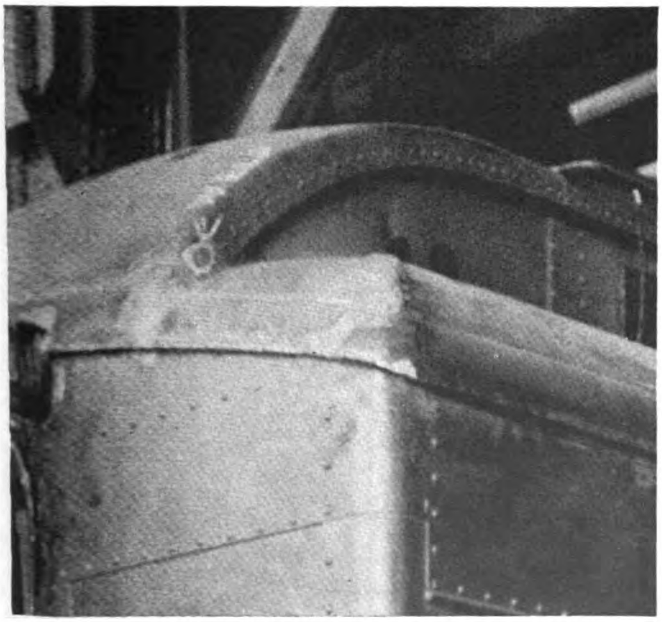


Battery boxes in process of construction by electric welding at Beech Grove shop

up the operation. The gusset plates are then applied and the Z-bar floor stiffeners, also the angle supports, and the doors last.

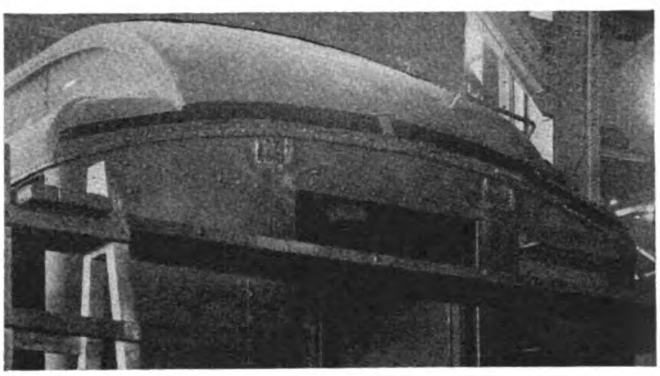
Referring to the second illustration, a composite riveted and welded passenger coach step is shown upside down on the coach-shop floor in order to give a better view of the welding on the underneath portion. As indicated, the angles on the step sides are riveted in place. The treads and risers, however, are applied by welding to the angles. The risers are tack-welded to the tread.

Electric welding is also used to great advantage in renewing corroded sections of passenger-car side and roof sheets which would otherwise have to be entirely removed and replaced. Where side sheets are corroded at the connection to the side sills, for example, the sheet is ripped the entire length of the car a distance of about 15 in. above the sill, using a pneumatic hammer and chisel. A new section of sheet is laid out and applied to the car side, the bottom of the patch being riveted to the side sill and the upper edge butt-welded to the old sheet, using No. 7 coated wire. The seam is tack-welded every 4 in. and the intermediate space then filled in. The welded joint is subsequently smoothed with an angle grinder and the job completed at a fraction of the cost of previous methods.



Welding successfully used for making repairs at car roof corners

In making repairs to corroded roof sheets, the defective section is removed by ripping the sheet about 6 in. above the drip molding and applying a patch made of No. 16 gage material. The upper edge of this patch laps



Corroded car roof end sheet cut away ready for patching

under the old roof 2 in. and is held in place for the welding operation by self-tapping screws spaced about 5 in. apart. The lower edge is clamped to the drip molding every 4 in., a space of ⅛ in. being left to be filled in by the welding bead. The way in which this is done, as well as the general method of repairing corroded roof corners, is shown in one of the illustrations.

Questions and Answers On the AB Brake

51—*Q.—What is the duty of the vent valve and piston?* A.—To vent brake-pipe air to atmosphere during emergency.

52—*Q.—What is the duty of the accelerated-release piston?* To prevent the return of emergency piston to release until a predetermined brake-pipe pressure is restored.

53—*Q.—What is the duty of the spill-over and ball check?* A.—Provides against over-charge of the quick-action chamber.

54—*Q.—What is the duty of the accelerated-release*

and ball check? A.—To provide secondary build up of brake-pipe pressure (after emergency) from the combined auxiliary-reservoir and brake cylinder volumes, when the emergency slide valve moves to accelerated release position.

55—*Q.—What is the duty of the inshot piston and valve?* A.—Controls the first stage of emergency brake-cylinder pressure development.

56—*Q.—What is the duty of the timing valve?* A.—Starts the final stage of emergency brake-cylinder development.

57—*Q.—For what purpose is the inshot piston volume chamber?* A.—Serves to annul controlled brake-cylinder pressure (which prevails in emergency) during a service application, and modifies the controlled build up (in emergency) when service precedes an emergency application.

58—*Q.—Name the various choke plugs in the emergency portion and locate them.* A.—(1) Spill-over choke in the emergency portion body, in the bushing under the spill-over ball check. (2) Choke in the upper cover, in the port between the chamber above the spill-over valve and the chamber above the strut diaphragm. (3) Vent-piston choke located in the vent-valve piston. (4) Delay choke plug located in the emergency-portion body, access to which can be effected by the removal of a brass pipe plug. (5) Quick-action chamber charging choke located in the charging port in the emergency portion body under the upper cover. (6) Choke located at the flange of the accelerated-release piston cylinder, in the port leading from the slide-valve seat to the chamber back of the accelerated-release piston. (7) Timing choke under the emergency portion cover, in the port which passes the delay-choke plug when the timing valve opens.

59—*Q.—What is the size of the opening and duty of the spill-over choke?* A.—$^3/_{64}$ in. Its duty is to protect against excessive spill-over-valve leakage.

60—*Q.—Give the size opening and duty of choke 97a.* A.—$^1/_{32}$ in. Its duty is to restrict the flow of air to the chamber above the strut diaphragm in case of diaphragm leakage.

61—*Q.—Give orifice size and duty of vent-piston choke 109.* A.—No. 69 drill (.029 in.). Controls the rate of quick-action-chamber pressure reduction during an emergency application.

62—*Q.—What is the size and duty of the delay-choke plug 127?* A.—$^3/_{32}$ in. Controls the second stage flow of air to the brake cylinder immediately after the inshot valve closes during an emergency application.

63—*Q.—What is the size and duty of quick-action-chamber charging choke 138?* A.—No. 73 drill (.024 in.). The duty is to control the quick-action-chamber charging rate.

64—*Q.—What is the opening of choke 140 and its duties?* A.—$^1/_{32}$ in. Serves to protect against excessive leakage past the accelerated-release piston and its seal, and also to prevent "slamming" of the piston to the extreme left by restricting the flow of air displaced by the piston.

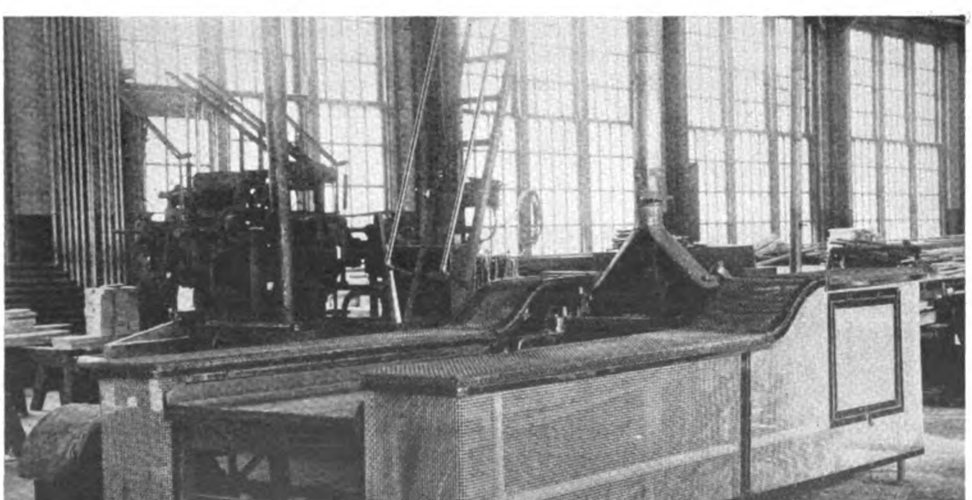
65—*Q.—How many springs are contained in the emergency portion?* A.—Eleven springs.

66—*Q.—Name them.* A.—(1) Accelerated-release check-valve spring. (2) Spill-over check-valve spring. (3) Diaphragm spring. (4) Vent-valve spring. (5) Inshot piston spring. (6) Inshot check-valve spring. (7) Emergency piston spring. (8) Graduating-valve spring. (9) Return spring. (10) Piston inner spring. (11) Piston outer spring.

67—*Q.—It being understood that the purpose of the valve springs is to hold the valves to their seats, define the duties of the other springs mentioned.* A.—(1) Diaphragm springs serve to hold the slide valve to its seat when the diaphragm is balanced. (2) Inshot-piston spring resists inshot-piston movement until the brake-cylinder pressure rises to 15 lb. (3) Return spring returns the piston and slide valve to normal release position when brake-pipe and quick-action chamber pressures are equalized. (4) Piston inner spring serves to resist movement of the emergency piston to accelerated release position at the beginning of release after an emergency application. (5) Piston outer spring serves the same purpose.

Mill Room Machinery Guards

Unusually neat, substantial and attractive mill-room machinery guards are being used at the Beech Grove, Ind., shops of the Big Four, as shown in the illustration. These guards are made primarily of No. 12 gage galvanized wire screen mounted on $1\frac{1}{4}$-in. pipe framework rigidly secured to the mill-room floor by means of stove



Well guarded 30-in., single-head planer at the Beech Grove shop mill room

bolts through the pipe flanges. Metal binding for the corners of the guards and various joints, removable covers, etc., consists of No. 16 gage galvanized iron, with a 1½-in. face, subsequently painted black, giving the guards an unusually workmanlike and trim appearance.

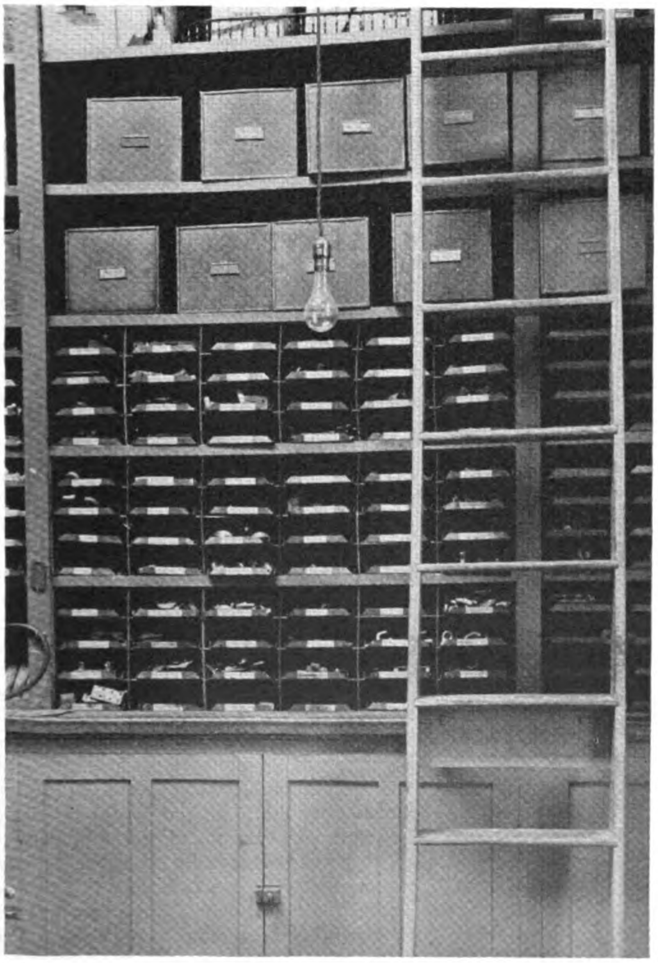
The machine illustrated in the foreground is a 30-in. single-head wood planer which may be operated with entire safety by use of the guard shown. All other planers and power-driven machines in the shop are similarly guarded. One guard is placed over each sanding element of the double-disk sanding machine while the other element is being used. The usual cutter and knife guards are provided on all machines. The endless belt sander is guarded at the ends in case the belt should break when anyone is passing. Shapers and band saws are similarly guarded. The use of goggles is required and it is said that no reportable injury has occurred in this mill room in three years.

Car Shop Tool Room

The tool-checking system at the Denver & Rio Grande Western passenger car shops, Denver, Colo., is perhaps not unique in all particulars, but it does give effective control of the tool situation by the issuance of a limited number of metal checks to each man, to be left at the tool room in exchange for any tools which may be needed in the various shop operations.

As compared to previous more or less hit-or-miss methods of issuing pneumatic tools, wrenches, drills, taps, electric light extensions, etc., a large saving is realized in that these tools and supplies are now intensively used and not allowed to accumulate and lie idle in the lockers and work boxes of individual shop men. Moreover, the frequent return of these tools to the toolroom permits maintaining a better check on their condition, as defective or worn out tools are replaced by new ones. The number of broken tools is also substantially reduced, as a man who breaks a drill, for example, is required to return the broken parts before a new drill is issued, and after the third experience of this kind, the shop man has to see the general foreman who points out, in a more or less emphatic manner, the cost of tool breakage and endeavors to find out if the man is simply careless or if there are some adverse conditions connected with his particular drilling operation which need to be corrected.

The toolroom is fully equipped with neat metal boxes, trays and lockers in which supplies and hardware for individual cars going through the shop for repairs are kept. In the illustration, for example, hinges, locks and relatively large parts are kept in the upper metal boxes; window fixtures, screws and other small parts are kept in the trays; and various tools and bulky materials are kept in the lockers underneath.

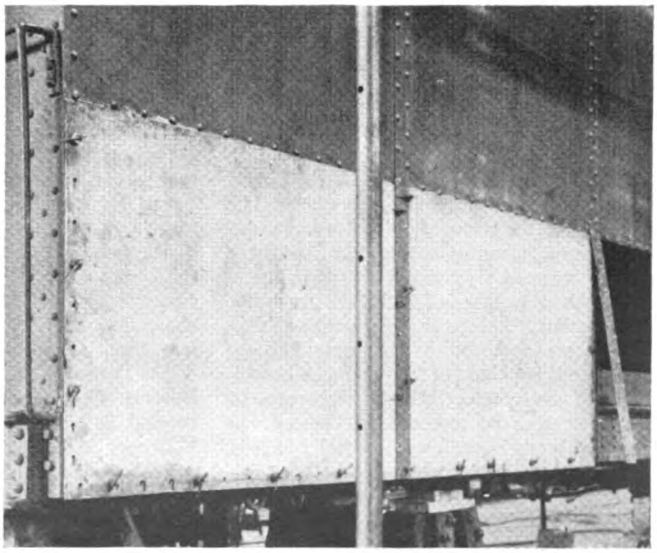


Individual metal storage boxes and trays at D. & R. G. W. passenger shop tool room

Repairing Side Sheathing

In cases where the lower side sheathing of steel passenger cars is corroded, repairs are made at the Denver, Colo., shops of the Denver & Rio Grande Western by the application of new steel sheathing strips in place of the corroded sections which have been cut out.

The illustration shows a baggage car in which the defective sheathing has been cut away and new steel installed, fitting up bolts applied to hold the plates in place, and everything made ready for the welding operation at the upper joint. In the case of this particular car, the side sheathing is being renewed from the side sill to the belt rail. Rivets are applied in the side sill and corner post after the welding operation. The weld is ground smooth and, after the final painting operation is performed, the application of the new sheathing can hardly be detected.



Corroded section of side sheathing replaced by new steel sheet on D. & R. G. W. baggage car

Among the Clubs and Associations

New England Railroad Club.—Col. J. T. Loree vice-president and general manager of the Delaware & Hudson, will be the guest speaker at the October 13 meeting which will be held at the Hotel Touraine, Boston, Mass., at 6:30 p.m.

International Acetylene Association.—The thirty-seventh annual convention of the International Acetylene Association will be held on November 18, 19 and 20 at the Jefferson Hotel, St. Louis, Mo. Technical sessions featuring the oxyacetylene process for welding metals will be held each afternoon and on two evenings. Wednesday evening, November 18, will be devoted to a forum on welding and cutting, and the evening session on Thursday, November 19, is intended to comprise a series of round-table discussions on oxyacetylene welding and cutting practices.

New York Railroad Club.—The first fall meeting of the New York Railroad Club will be held on Friday evening, October 16, at 7:45 p.m. at the club's usual meeting place—the auditorium of the Engineering Societies building, 29 West Thirty-ninth street, New York. The subject for discussion will be the New York, New Haven & Hartford train which was converted by the Edward G. Budd Manufacturing Company from two old steel coaches, and equipped with the Besler steam power plant. George D. Besler will show pictures of, and describe the power plant; a representative of the Budd company will discuss the modernization of the train, while a representative of the New Haven will tell something about the inception of the idea.

Master Boiler Makers Meet at Chicago

The twenty-third annual meeting of the Master Boiler Makers' Association, held at the Hotel Sherman, Chicago, September 16 and 17, was attended by about 175 members of the association and guests. At the business meeting a year ago, the first after a lapse of five years, the association undertook the task of rehabilitating the organization. This year, the results of this effort were apparent in the increased interest and backing of the principal railroads of the country, practically everyone of which was represented. ¶The efforts of the officers have been directed towards a complete modernization of the association. To this end, the by-laws were revised in a manner to make possible the most efficient handling of association affairs in the future. Henceforth, the officers to be elected will include a president, secretary-treasurer and an executive board of nine members. This board will elect one of its members as vice-president of the association, who will also serve as chairman of the board. To be eligible for the office of president or vice-president, a member must have had at least one year's experience on the executive board. ¶One of the principal features of the meeting was an address on the aims of the Bureau of Locomotive Inspection, which was delivered by John B. Brown, assistant chief inspector of the bureau. A special paper, contributed by the research committee of the International Acetylene Association, on the subject "Applications of Oxy-Acetylene Welding and Cutting in Locomotive Boiler Upkeep and Repairs," was presented by the chairman of the committee, C. W. Obert. ¶Special committee reports covering various phases of locomotive boiler work were presented and discussed widely by the membership. The subjects and personnel of the committees follow: "Boiler and Tender Pitting and Corrosion." Committee: J. L. Callahan, special representative, National Aluminate Corporation (formerly general boiler inspector, Chicago Great Western), chairman; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific; J. P. Powers, system general boiler foreman, Chicago & North Western. ¶"Proper Brick Arch Setting in Locomotive Fireboxes." Committee: E. E. Owens, general boiler inspector, Union Pacific, chairman; B. G. King, assistant general boiler inspector, Northern Pacific; H. A. Bell, general boiler inspector, Chicago, Burlington & Quincy; C. F. Totterer, general boiler foreman, Alton. ¶"Autogenous Welding as Applied to Locomotive Boilers and Tenders." Committee: Albert F. Stiglmeier, boiler foreman, West Albany Locomotive Shops, New York Central, chairman; John A. Doarnberger, master boiler maker, Norfolk & Western; S. Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe; G. E. Stevens, general boiler inspector, Boston & Maine. ¶"Proper Thickness of Front Tube Sheets." Committee: Walter R. Hedeman, assistant mechanical engineer, Baltimore & Ohio, chairman; C. A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis; E. C. Umlauf, supervisor of boilers, Erie Railroad; R. A. Pearson, general boiler inspector, Canadian Pacific. ¶"Proper Methods of Applying All Types of Staybolts to All Types of Boilers." Committee: Leonard C. Ruber, superintendent boiler department, Baldwin Locomotive Works, chairman; George M. Wilson, general boiler supervisor, American Locomotive Company; M. V. Milton, chief boiler inspector, Canadian National; C. W. Buffington, general master boiler maker, Chesapeake & Ohio. ¶"Improvements in Locomotive Front Ends." Committee: J. M. Stoner, supervisor of boilers, New York Central Lines West, chairman; E. M. Cooper, district boiler inspector, Baltimore & Ohio; H. E. May, general boiler and locomotive inspector, Illinois Central; G. L. Young, boiler foreman, Reading.

Election of Officers

The annual election resulted in the following officers being selected for the ensuing year: President: M. V. Milton, chief boiler inspector, Canadian National, Toronto, Ont., Can. Secretary-Treasurer: Albert F. Stiglmeier, general foreman boiler maker, New York Central, Albany, N. Y. ¶Executive Board (one year): George L. Young, foreman boiler maker, Reading, Reading, Pa.; C. W. Buffington, general master boiler maker, Chesapeake & Ohio, Richmond, Va.; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific, Minneapolis, Minn. ¶(Two years): M. V. Milton, chief boiler inspector, Canadian National, Toronto, Ont., Can.; Charles J. Klein, locomotive inspector, Bureau of Locomotive Inspection, Albany, N. Y.; Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford, East Milton, Mass. ¶(Three years): William N. Moore, general boiler foreman, Pere Marquette, Grand Rapids, Mich.; Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis, Indianapolis, Ind.; E. C. Umlauf, supervisor of boilers, Erie, Susquehanna, Pa.

Fuel and Traveling Engineers' Associations Unite

In the interests of economy and increased effectiveness, as well as to meet the wishes of higher railway officers, the International Railway Fuel Association, organized 27 years ago, and the Traveling Engineers' Association, which has been functioning for 44 years, have united to form a single association known as the Railway Fuel and Traveling Engineers' Association. The announced objective of the new association is "to improve the locomotive service and the use of fuel on all railroads," and it was formally organized at joint business meetings of the two associations held at the Hotel Sherman, Chicago, September 15 to 18, inclusive. ¶The work of actually merging the two associations was performed by a special committee of 12 men from each, duly authorized to effect the consolidation, elect temporary officers, appoint committees and conduct the affairs of the association during the current year. International Rail-

way Fuel Association members elected to represent the association on this special joint committee included: C. I. Evans, M-K-T, president; J. D. Clark, C. & O.; A. A. Raymond, N. Y. C.; R. Collet, St. L.-S. F.; J. R. Jackson, M. P.; E. G. Sanders, A. T. & S. F.; C. N. Page, L. V.; L. E. Dix, T. & P.; M. F. Brown, N. P.; G. H. Likert, U. P.; J. E. Davenport, N. Y. C., and Secretary-Treasurer T. Duff Smith. The Traveling Engineers' Association elected as its representatives on the special committee M. A. Daly, N. P., president; J. M. Nicholson, A. T. & S. F.; Ralph Hammond, N. Y. N. H. & H.; G. M. Boh, Erie; W. C. Shove, N. Y. N. H. & H.; J. C. Lewis, R. F. & P.; J. J. Kane, L. V.; C. C. Hipkins, Penna.; A. E. Johnson, C. M. St. P. & P.; W. H. Davies, Wabash, and F. P. Roesch, Standard Stoker Company. ¶At the first meeting of the joint committee, presided over by F. P. Roesch, the following officers were elected to conduct the affairs of the association during the coming year, which includes presiding at the 1937 meeting: Chairman, J. D. Clark; Vice-Chairman, C. I. Evans; Vice-Chairman, A. T. Pfeiffer; Vice-Chairman, F. P. Roesch; Secretary-Treasurer, T. Duff Smith, the latter having offices at 1660 Old Colony building, Chicago. The following committees were appointed: Committee on Constitution and By-Laws—R. Collett, J. R. Jackson, M. A. Daly, J. E. Davenport and L. E. Dix; Committee on Committees —A. A. Raymond, G. H. Likert, W. C. Shove, G. M. Boh and C. C. Hipkins; Committee on Audit and Transfer—T. Duff Smith, C. N. Page and F. P. Roesch; Committees on Subjects for the 1937 Annual Meeting—J. M. Nicholson, A. T. Pfeiffer, M. F. Brown, W. H. Davies, J. C. Lewis and R. Hammond. ¶During the course of the meetings of the two associations, at which there was a total registration of approximately 300, numerous informative reports were presented for consideration. The Traveling Engineers' Association discussed the function of the traveling engineer, what has been accomplished by extending locomotive runs, brakes on high-speed trains, and high-speed passenger locomotives. ¶In addition to receiving the usual standing committee reports on fuel economy devices, stationary boilers, firing practice, fuel stations, etc., the International Fuel Association was addressed by C. F. Richardson, president of the West Kentucky Coal Company, and by Lewis Ware, president of the United Electric Coal Company.

General Foremen Elect Officers

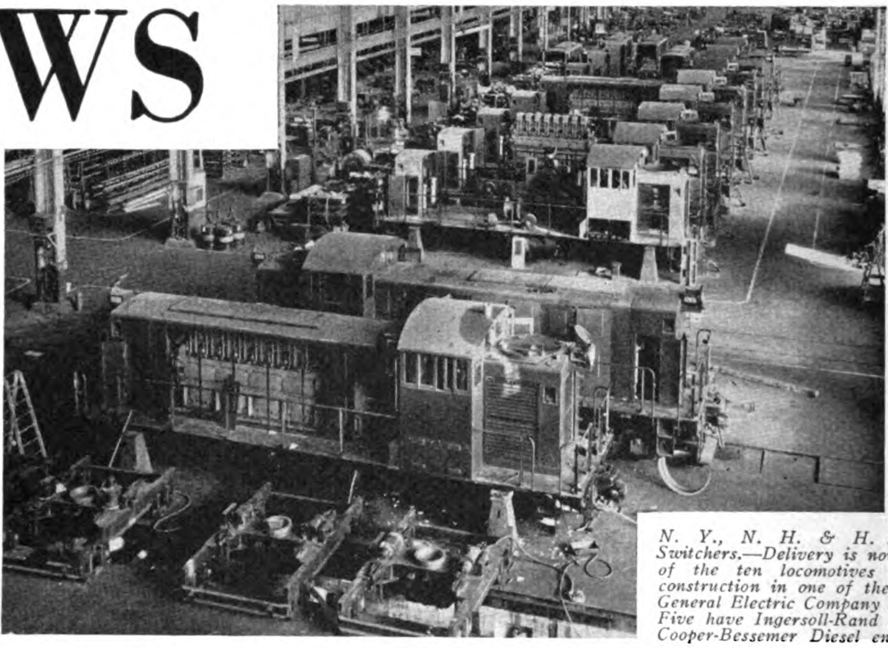
Three subjects, or committee reports, were presented at the thirtieth annual meeting of the International Railway General Foremen's Association held September 15 and 16 at the Hotel Sherman, Chicago. The meeting was presided over by President A. H. Keys, district master car builder, Baltimore & Ohio, Pittsburgh, Pa., and the subjects considered were Maintenance of Diesel Locomotives, Production Methods in Locomotive Repairs and Maintenance of High-Speed Passenger Equipment. ¶At the close of the business session, the following officers were elected for the ensuing year: President, F. T. James, general foreman, Delaware, Lackawanna & Western, East Orange, N. J.; First Vice-President, F. B. Downey, general foreman, Chesapeake & Ohio, Huntington, W. Va.; Second Vice-President, J. Oxley, general car foreman, Chicago & North Western, Chicago; Third Vice-President, Charles C. Kirkhuff, general foreman, Atchison, Topeka & Santa Fe, Chicago; Secretary-Treasurer, William Hall, Winona, Minn.

Club Papers

Why Federal Inspection ?

Central Railway Club.—Meeting held September 10 at Buffalo, N. Y. Address by John M. Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission. ¶In his address under the above title, Mr. Hall reviewed the results of 25 years of locomotive inspection by the federal government and the reasons which led to the enactment of the laws regulating the condition of locomotives operating in interstate commerce. The first of these was the Ash Pan Act, which became effective January 1, 1910. It was followed by the Boiler Inspection Act, which became effective July 1, 1911. This act was extended to include the entire steam locomotive and tender by amendment which became law on March 4, 1915, and was further extended to include locomotives propelled by other power than steam by amendment which became law on June 1, 1924. In developing the reasons for the enactment of these laws Mr. Hall quoted extensively from the testimony presented in the hearings before the committees of Congress during the years preceding the final passage of the Act and its amendments. ¶In his introductory remarks Mr. Hall said: "Our purpose in investigating accidents is not mere curiosity, but is for the purpose of preventing reoccurences of similar mishaps. The matter of boiler explosions, which I shall show you, have been reduced 90 per cent during the 25 years this law has been in force. We go into these accidents very, very thoroughly. We are human. We have a human interest in those that have gone and left sorrowing ones behind. We also have a very human interest in those who are crippled—perhaps for life. ¶"In investigating what we term 'crown sheet accidents' there are infallible indications that point out to us if the particular accident was due to low water. I want to prove to you that we do carefully investigate all such accidents. We never go to an accident with our mind made up. We investigated such accidents in the early years of the law and one or two not so very long ago that were not due primarily to low water, but due to bad water. Let me tell you the difference briefly. ¶"In a legitimate case of low water your crown sheet is overheated uniformly. The extent of overheating depends on the height of the water, or, in other words, how low the water has become and the part of the firebox sheets that are uncovered and exposed to the terrific heat from the fire. The more intense the heat and the lower the water, the bluer the color. In many cases there is almost always a gray line, or what we call the low-water line, plainly visible. ¶"We have investigated accidents caused by improper conditions that possibly 25 years ago would have been called low-water cases — man-failures. There was no one to contradict, because there was no federal investigation. I do not mean to imply that mechanical officials were dishonest, but I do say they had to do some things before the Boiler Inspection Law that they did not want to do; in other words, they frequently went to the scene of the accident with their minds made up. ¶"There is a decided difference in the indications of a boiler explosion when such explosions are due to low water than, for instance, an accident due to mud or scale adhering to the crown and other firebox sheets, in the latter cases the crown sheet will only show overheating at such places where the mud or scale had been, and almost invariably the overheating will be in areas perhaps 24 in. in diameter or larger or smaller spots, as the case may be, while in cases of low water the highest portion of the crown sheet will usually show uniform overheating. ¶"If there are defective crown-stay or firebox sheets that cause or contribute to the accident. we can find the evidence of such defective conditions and they are plainly covered in our accident reports. There is a difference between an actual low-water case and a case of overheating due to scale or mud. ¶"We have had cases where the boiler explosion was due to bad water. In that case almost invariably you will find the side sheets of the firebox a deeper blue than the crown sheet itself, and, as you know, the crown sheet is the highest part of the firebox. In that case you will find the overheating is spotty. There may be two or more places on the crown sheet that will indicate the lack of water and down on the side sheets you will find that same indication. ¶"I want you to know that our purpose in investigating accidents is not to 'hang' it onto anybody. We do not put anybody in jail. We do not penalize the individual, nor do we penalize the railroads, unless we find the water glass stopped up, injectors inoperative or other defective conditions. We have had some cases of this kind where the tubular type of water glass was carelessly applied—sometimes the glass was too short and the rubber gasket, due to heat, will shrivel and close one end or another of the water glass, which will result in a false indication of water. I remember we investigated an unmistakably low water case some years ago. The water glass was standing half full of water when we made our investigation because the bottom of the water glass was plugged solid with a rubber gasket." ¶The results of federal inspection are shown by the following facts pointed out by Mr. Hall: Accidents to boilers and appurtenances declined from 856 in the first year, ended June 30, 1912, to 74 during the year ended June 30, 1936. The killed declined from 91 to 10, and the injured from 1,005 to 79 during the same period. Machinery accidents since 1917 have decreased 40 per cent; the number killed, 30 per cent, and the number injured, 49 per cent.

NEWS



N. Y., N. H. & H. Diesel-Electric Switchers.—Delivery is now being made of the ten locomotives shown under construction in one of the shops of the General Electric Company at Erie, Pa.—Five have Ingersoll-Rand and five have Cooper-Bessemer Diesel engines

Denver Zephyrs Complete 200,000 Miles

The Advance Denver Zephyrs of the Chicago, Burlington & Quincy, which were placed in service on a 16-hour schedule between Chicago and Denver, Colo., on May 31, completed 200,000 miles on September 5. During this 97-day period, the Advance Zephyrs were late only four times. The schedule calls for an average of 65 miles an hour. A total of 14,669 passengers was carried on the 194 trips.

Improvement Programs

The Elgin, Joliet & Eastern will repair 300 box cars in its own shops.

The federal district court at St. Louis, Mo., has authorized the trustee of the Missouri Pacific to install Evans automobile loading devices in 150 additional box cars, and to modernize 208 cars, already equipped with such devices, by the installation of parts that will permit the loading of late model automobiles. The work will cost $180,850.

C. R. I. & P. Awards Contract for Shop Building

The Chicago, Rock Island & Pacific has awarded a contract to A. H. Newman, Des Moines, Iowa, for the construction of an 80-ft. by 120-ft. shop building at East Des Moines and an 11-stall addition to its enginehouse at the same point, at a total cost of about $125,000. The shop building will be of brick construction with a timber roof carried on steel trusses, while the enginehouse extension, also of brick construction, will have a frame roof.

Smoke Prevention Manual

The Smoke Prevention Association has issued an 82-page illustrated "Manual of Smoke and Boiler Ordinances" which not only lists the local smoke abatement boards and requirements in various cities throughout the United States, but also contains much useful information regarding how to secure more efficient combustion and hence a reduction of the smoke nuisance. The book contains a Ringleman chart for grading smoke density, a code for rating heating boilers, a table of head room requirements for smokeless boiler settings, and excerpts from papers presented at recent conventions of the Smoke Prevention Association. This book, which is valuable for reference purposes, may be secured by writing to the executive offices of the association, City Hall Square building, Chicago.

P.R.R. Research Activities

How the Pennsylvania, through research and experimentation, utilizes the advances of science, new inventions and improved technical processes for the improvement of its freight and passenger service is told in a special report which has recently been made public.

While it points out that the Pennsylvania has conducted research practically from its inception, the report deals most fully with nine outstanding projects recently completed or still under way, among which are:

1. Special electric locomotive tests at Claymont, Del., over a section of track equipped with instruments to measure the pressures and stresses of locomotive wheels on the rails.

2. Development of the streamline contours of the new electric and steam locomotives through wind tunnel tests, in which, for the first time, clay models capable of immediate alteration in shape were used.

4. Locomotive road tests over various sections of the system, using electrically-operated instruments which recorded on a photographic film the forces exerted at the axles and elsewhere on the locomotives at various speeds.

6. Extensive research in air-conditioning passenger cars, producing improved apparatus and a scientific scale of differentials between interior and exterior temperatures for maximum health and comfort.

7. The development of a new spring arrangement for freight cars to prevent excessive vertical movements of the car body and protect the contents from damage.

In 1874 the Pennsylvania established a department of physical tests at its Altoona, Pa., shops, followed by a chemical laboratory in 1875 and a bacteriological laboratory in 1889. These were the first test plants of their kind developed by any railroad. Since 1905 a locomotive test plant has been an important feature of the research equipment.

L.C.L Refrigerator Container Being Developed

An l.c.l. refrigerator container, which can be picked up and delivered by truck and be transported by railroad in a standard 40-ft. box car, is being tested by the Universal Carloading & Distributing Company, Chicago. The outstanding feature of the container is its lightness, its total weight being 550 lb., and its load capacity 210 cu. ft. The container, which is being constructed by the Sterling Lumber Company, Chicago, is made of wood, and has bunkers for 150 lb. of dry ice, enough to carry shipments through four days' transit without re-icing. The containers are insulated with Silvercote, a product of Silvercote Products, Inc. The containers also have electrical connections for the preheating of interiors for perishable movement during winter weather. The containers have a side dimension of seven by seven feet and front and back dimension of five by seven feet. Six can be loaded in a standard 40-ft. box car.

Because of the ease with which the containers can be handled on dollies the Universal Carloading & Distributing Company plans to purchase 100 of these containers.

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Supply Trade Notes

R. B. Nichols, manager of the Chicago office of the Bantam Ball Bearing Company, has been promoted to manager of the Industrial Bearing division.

Hoyle Jones, formerly president of the Superior Tube Company, has been appointed district sales manager of the Republic Steel Corporation, with headquarters in Tulsa, Okla.

Frederick O. Schramm has been appointed district sales agent for New York and vicinity of the Pittsburgh Steel Foundry Corporation, Glassport, Pa. Mr. Schramm's headquarters are at 11 West 42nd street, New York City.

The Timken Steel & Tube Company's New York office, in charge of Arthur R. Adelberg, district manager, is now located at 165 Broadway. Mr. Adelberg formerly had his office in the Timken Roller Bearing Company offices at 16 West 60th street.

George W. Norris, Philadelphia, Pa., former governor of the Federal Reserve Bank of Philadelphia, and Matthew S. Sloan, New York, chairman of the board and president of the Missouri-Kansas-Texas, have been elected directors of the Edward G. Budd Manufacturing Company, Philadelphia, to fill vacancies on the board. Mr. Norris also was elected chairman of the finance committee, consisting also of Mr. Sloan and W. W. Colpitts, of New York.

The Carnegie-Illinois Steel Corporation, a subsidiary of the United States Steel Corporation, has adopted a new trade name, USS CARILLOY, to identify the entire group of alloy steels previously marketed as Carnegie-Illinois alloy steels.

George I. Wright has been appointed manager transportation department of the Westinghouse Electric & Manufacturing Company, with headquarters at East Pittsburgh, Pa. He has charge of engineering and sales of equipment supplied to the transportation industry.

Herbert A. May has resigned as vice-president of the Safety Car Heating & Lighting Company to become vice-president of the Union Switch & Signal Company, with headquarters in Pittsburgh, Pa. Mr. May will retain his interest in the Safety Car Heating & Lighting Company, of which company he will continue as a director.

James S. Hearons has been appointed assistant manager of sales, Railroad division of the Inland Steel Company, Chicago. Peter M. Lorenz has been appointed district sales manager and Frederick A. Ernst has been appointed assistant manager of the St. Louis office. Mr. Hearons attended school in the East, and began work as a special apprentice on the Erie in 1906, and later became associated with the Illinois Central. During the World War he served in the A. E. F. as captain in the Engineering division. Prior to his Inland appointment, Mr. Hearons was assistant to the president of the Clark Equipment Company, specializing on railroad sales.

Arthur T. Herr has been appointed vice-president in charge of sales of the Union Railway Equipment Company, Chicago, in the territory adjacent to Denver, Colo., with headquarters in the Equitable building, Denver. Mr. Herr began his career with the Westinghouse Air Brake Company at Pittsburgh, Pa., and in 1916 organized the A. T. Herr Supply Company at Denver, which company he will continue to head.

Arthur T. Herr

William E. Corrigan, assistant vice-president, has been elected vice-president of the American Locomotive Company, Railway Steel Spring Division, with headquarters at New York. Mr. Corrigan, who entered the service of the American Locomotive Company in 1909, is a graduate of the four-year course in locomotive construction which the company conducts in its engineering department at

William E. Corrigan

(Turn to next left-hand page)

New Equipment

Locomotive Orders

Road	No. of locos.	Type of loco.	Builder
Aliquippa & Southern	1[1]	0-8-0	American Locomotive Co.
Birmingham & Southern	5	900-hp. Diesel-elec.	American Locomotive Co.
Green Bay & Western	6[2]	4-8-4	American Locomotive Co.
Toledo, Peoria & Western	6	4-8-4	American Locomotive Co.
United Fruit Co.	5[3]	2-8-2	Baldwin Locomotive Works

Locomotive Inquiries

Road	No. of locos.	Type of loco.	Builder
Detroit & Toledo Shore Line	3	2-8-2	....
Great Southern Lumber Co.	1	2-8-2	....
Kansas City Southern	10	2-10-4	....
St. Louis-Southwestern	5	4-8-4	....

Freight Car Orders

Road	No. of cars	Type of car	Builder
Boston & Maine	750	50-ton gondolas	Bethlehem Steel Co.
Maine Central	500	Box	Magor Car Corp.
	100	Gondolas	Bethlehem Steel Co.
	150	Twin hopper	
Missouri Pacific[4]	200	40-ton box	Mt. Vernon Car Mfg. Co.
Union R. R.	100	70-ton gondolas	Ralston Steel Car Co.

Freight Car Inquiries

Road	No. of cars	Type of car	Builder
Kansas City Southern	750	50-ton box	....
	200	70-ton box	....

Passenger Car Orders

Road	No. of cars	Type of car	Builder
New York Central	2[5]	Coaches	Company shops

Passenger Car Inquiries

Road	No. of cars	Type of car	Builder
C. & E. I.	2	Rail motor, with pass. and mail compart.	....
C. & N. W.	2[6]	7-car trains	....

[1] This locomotive will have 25-in. by 28-in. cylinders and a total weight in working order of 231,000 lb.

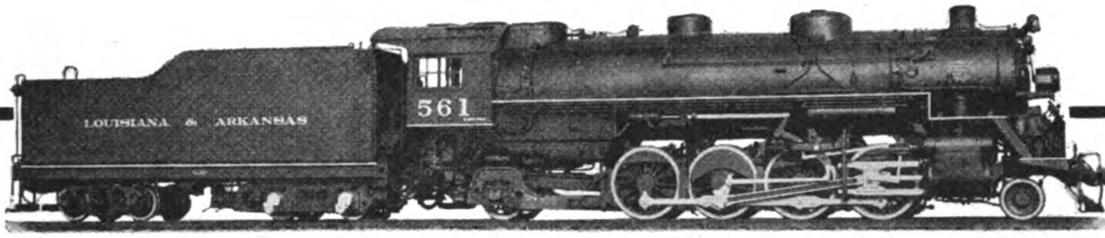
[2] These locomotives will have 23½ in. by 30 in. cylinders and a total weight in working order of 365,000 lb.

[3] For service in Guatemala.

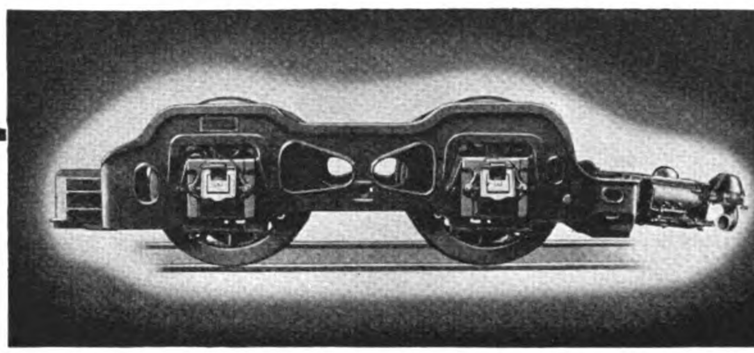
[4] Equipment to be assigned to New Orleans, Texas & Mexico.

[5] For "The Mercury." To be similar to those now in service on the train between Cleveland, Ohio, and Detroit, Mich.

[6] The inquiry is issued to ascertain comparative costs rather than with a view to immediate purchase. Each train to include one combination parlor-bar-lounge car, 2 first class coaches, 1 dining car, 1 lounge-parlor car, 1 parlor car and 1 parlor-drawing room-observation car, of light-weight alloy steel.



THIS NEW MODERN POWER
FOR THE LOUISIANA & ARKANSAS
INCORPORATES THE LOCOMOTIVE BOOSTER



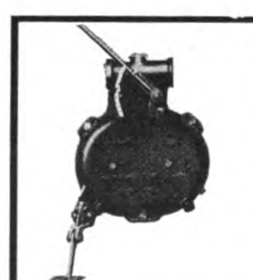
The Locomotive Booster

On the new Mikado Type Locomotives recently delivered by Lima Locomotive Works, Incorporated, to the Lousiana & Arkansas Railway the Locomotive Booster is incorporated as an integral part of the design.

This modern power carries 240 pounds boiler pressure and develops a starting tractive effort of 71,300 pounds of which the Booster delivers 16,500 pounds.

In any locomotive the Booster improves operation by quicker acceleration and smoother starting. It materially reduces maintenance costs by avoiding excessive starting stresses that cause undue shock and wear.

Modern power is Booster power.



The Franklin #8 Butterfly Type Firedoor increases the efficiency of locomotive firing.

When maintenance is required a replacement part assumes importance equal to that of the device itself and should be purchased with equal care. Use only genuine Franklin repair parts in Franklin equipment.

FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK CHICAGO MONTREAL

Schenectady, N. Y. From May, 1913, Mr. Corrigan served in various capacities in the drawing office at Schenectady until 1915, when he was transferred to the Cooke plant, Paterson, N. J., where he was engaged in elevation work and general calculating. He remained in that position until November, 1917, when he entered the United States Army, where he served consecutively as second lieutenant, first lieutenant and captain in the artillery ordnance branch, field service, in charge of plant production at several gun carriage and ammunition plants. Following the armistice, he served as secretary and then ordnance district chief and chairman of the claims board in charge of the settlement of claims arising out of the cancellation of war contracts between the government and various manufacturers. He re-entered the employ of the American Locomotive Company in 1920, serving for two years in the sales department at New York. He was then transferred to Chicago as salesman for Alco accessories in the middle western territory. In 1923 he was appointed general sales representative of the company on the Pacific Coast, with the title of district sales manager; in 1930 he became district sales manager at Cleveland, and in January, 1935, was appointed assistant vice-president of the American Locomotive Company, Railway Steel Spring Division.

Victor W. Ellet, vice-president of the Hunt-Spiller Manufacturing Corporation, Boston, Mass., has been elected president and general manager and Elbert J. Fuller, sales manager, has been elected vice-president. Mr. Ellet was born on

Victor W. Ellet

June 11, 1880, at Burlington, Iowa. In 1886 his parents moved to Fort Madison, Iowa, where he was educated in the public schools, and Johnson's Business College. He later took the railroad engineering course in the International Correspondence School. He served his apprenticeship as a machinist with the Atchison, Topeka & Santa Fe at Fort Madison, completing the apprenticeship in 1901. After this time he worked for the St. Louis, Iron Mountain & Southern (Missouri Pacific), Fort Worth & Denver City, and the old Choctaw, Oklahoma & Gulf, now a part of the Chicago, Rock Island & Pacific, returning later to the Santa Fe at Fort Madison. He also served as expert tool maker in the United States arsenal at Rock Island, Ill. In 1905 he returned to railroad service as mechanical foreman on the Missouri Pacific at Hoisington, Kan. The following year he entered the service of the Chicago, Rock Island & Pacific as an executive in the mechanical departments at Valley Junction, Iowa; Fairbury, Neb.; Chicago, and Rock Island, Ill. In 1911 he entered the employ of Hunt-Spiller Manufacturing Corporation as mechanical representative. He was appointed sales manager in 1925, and vice-president in 1928. He now becomes president and general manager, succeeding the late John G. Platt. Mr. Ellet is a member of the executive committee of the Railway Supply Manufacturers Association, and a member of a number of railroad and engineering clubs.

Elbert J. Fuller was born in 1883 at Clinton, Iowa, where he was educated in

(c) Bachrach

Elbert J. Fuller

the public schools. At an early age he entered the service of the Chicago & North Western as a machinist apprentice at Clinton. After completing his apprenticeship and serving as a machinist at Clinton, he was promoted to a supervisory position in the mechanical department. During the years 1911, 1912 and 1913 he was chief inspector of new equipment for the Chicago & North Western at the works of the American Locomotive Company, Schenectady, N. Y. He left railroad service on April 1, 1914, to enter the employ of the Hunt-Spiller Manufacturing Corporation. He served as mechanical representative until his appointment as assistant sales manager October 1, 1927, holding this position until March 21, 1928, when he became sales manager. In addition to his present capacity as vice-president, Mr. Fuller has been appointed sales manager.

J. E. Buckingham has been elected vice-president in charge of sales for the Western district of the Lincoln Electric Railway Sales Company, with headquarters in the Straus building, 310 South Michigan avenue, Chicago. Mr. Buckingham began his railroad career in 1900 with the Union Pacific System at Salt Lake City, Utah, and Omaha, Neb. Eight years later he became master mechanic of the Union Stock Yards Company and still later was superintendent of the Motor and Refrigerator Division of Wells Fargo Express. He also has had experience in the railroad departments of the Baldwin Locomotive Works, the Standard Steel Company, and the Associated Oil Company. For the past 14 years he has been employed in the Railroad Sales Division of the Worthington Pump & Machinery Corporation, for the last five years being western regional manager, Railroad Division. During the war Mr. Buckingham was an officer in the Railroad Unit, U. S. Army, Company D, 87th Engineers.

Joseph Davis, executive vice-president of the American Locomotive Company, on account of ill health, tended his resignation, which was accepted on September 24 David Dasso was appointed vice-president of the Diesel-Engine Division with headquarters in New York, succeeding R. B. McColl, who has resigned to become president of Alco Products, Inc., a subsidiary of the American Locomotive Company. Mr. Davis also resigned as a director, member of the executive committee and president of Alco Products, Inc., division of the American Locomotive Company. Mr. McColl, in addition to being president, was appointed a director, and member of the executive committee of Alco Products, Inc., to succeed Mr. Davis.

E. M. Harshbarger, who has been connected with the railway division of SKF Industries, Inc., since early in 1927, has been appointed manager of railway sales,

E. M. Harshbarger

with headquarters at the home office of the company, Philadelphia, Pa. Mr. Harshbarger attended Purdue University and for several years prior to joining SKF Industries, Inc., was affiliated with S. F. Bowser & Company, Fort Wayne, Ind.

Frederic E. Lyford has been appointed assistant to Robert S. Binkerd, vice-president of the Baldwin Locomotive Works. Mr. Lyford, since February, 1934, has served as an examiner for the Railroad Division of the Reconstruction Finance Corporation, which position he resigned to join the Baldwin organization. He was born on January 20, 1895, and was graduated in mechanical engineering from Cornell University. After a year in the service of a shipbuilding concern and a machine tool company, he entered the army, serving in the field artillery and in the air service in France as first lieutenant. In 1919, he became an assistant sales

manager of the Allied Machinery Company of America, resigning the following year to engage in advertising and sales promotion work for a milling company at Waverly, N. Y. In 1923 he entered the service of the Lehigh Valley as apprentice instructor, in connection with which he also directed classes for the instruction of mechanical department foremen. Subsequently, he served three years as assistant general machine foreman at the Sayre locomotive shops of the Lehigh Valley, during which period he also handled engineering problems for the shop superintendent. Later, Mr. Lyford was promoted to the position of special engineer to the executive vice-president, making studies of a wide variety of mechanical department subjects, including water treatment, locomotive lubrication and the design and economy of new power. In February, 1934, he left the Lehigh Valley to become an examiner for the Railroad division of the Reconstruction Finance Corporation.

F. E. Lyford

EVERETT CHAPMAN, vice-president of Lukenweld, Inc., Coatesville, Pa., has been elected president to succeed G. Donald Spackman, who has been appointed general superintendent of the Lukens Steel Company. Robert J. Whiting, superintendent of Lukenweld, Inc., in charge of all manufacturing, has been elected vice-president of Lukenweld.

Everett Chapman

Everett Chapman was born in Detroit, Mich., on May 9, 1901. He attended grade school and high school at Detroit and was later employed by the Detroit Testing Laboratories. In 1919 he entered the University of Michigan, where he obtained the degree of bachelor of science in electrical engineering in 1923. After a year's graduate work in physics, his senior thesis on electrical vibration of high frequencies having gained for him the degree of master of science, he became an instructor in electrical engineering at Purdue University. In 1925 he joined the Lincoln Electric Company, Cleveland, Ohio, as an experimental engineer. In 1930 he became director of development and research of Lukenweld, Inc., of which company he was elected vice-president early in 1934.

Robert J. Whiting, vice-president of Lukenweld, was born in 1885 at Foster, Pa. He attended grade school, high school and business college at Scranton, and in 1906 obtained employment with the Keller Manufacturing Company, Scranton, vehicle manufacturers. In 1909 he entered the service of the Pickering Engineering Company, Hartford, Conn., where he was engaged principally in problems of structural design concerned with power-plant equipment. In 1913 he became master mechanic on plant equipment for the Ford Motor Company, Detroit, later being appointed superintendent of body construction at the Ford plant. During the war he was in charge of the men employed at the Ford Motor Company for the construction of boats for the United States Navy. In 1923 he became production engineer for the Fisher Body Corporation, and for 4½ years was manager of Fisher's Flint, Mich., unit No. 1. In May, 1934, Mr. Whiting resigned to become superintendent of Lukenweld, Inc.

R. J. Whiting

Obituary

HARRY ORVILLE FETTINGER, New York railroad representative of the Ashton Valve Company, Boston, Mass., died on August 20 of a heart ailment after a long illness, at his home in Roselle, N. J., at the age of 67 years. Mr. Fettinger was born at Altoona, Pa., and began work in 1887 as machinist apprentice in the Altoona machine shops of the Pennsylvania, later serving consecutively as journeyman machinist, inspector in the office of superintendent of motive power and inspector in the office of general superintendent of motive power. From 1904 until 1906, he was air brake and steam heat inspector, then chief air brake and steam heat inspector of the Pennsylvania System; later in the same year he entered the supply business. From 1906 to 1911 he was a salesman in the railroad department of the Johns-Manville Corporation, then to 1914 he was a representative of the Safety Car Heating & Lighting Company. In 1914 he entered the service of the Ashton Valve Company and for 22 years served as manager of its railroad department in New York. In addition to his membership in technical organizations Mr. Fettinger was interested in civic affairs, having served as president of the board of education of his home town.

H. O. Fettinger

O. H. MELLUM, assistant vice-president of the American Car and Foundry Company, with headquarters at Chicago, who was killed in Lake Bluff, Ill., on August 14, by a freight train while alighting from another train at that station, was born in 1890. Mr. Mellum entered the employ of the American Car and Foundry Company in 1904 as an office boy and messenger. After serving in various capacities, Mr. Mellum was appointed sales agent at Chicago, and in February, 1930, was promoted to assistant vice-president.

(c) Moffett Studio

O. H. Mellum

(*Turn to second left-hand page*)

Personal Mention

General

E. Becker, superintendent of motive power and equipment of the Green Bay & Western, at Green Bay, Wis., has been appointed mechanical inspector.

T. M. Kirkby has been appointed superintendent motive power and equipment of the Green Bay & Western, with headquarters at Green Bay, Wis.

T. W. Carr, master car builder on the Pittsburgh & Lake Erie, with headquarters at McKees Rocks, Pa., has been appointed superintendent of rolling stock, with the same headquarters, to succeed S. Lynn, deceased.

S. J. Hungerford, president of the Canadian National, has been appointed also chairman of the board, for a term of three years. Mr. Hungerford was born near Bedford, Que., in 1872 and entered railway service in 1886 as a machinist apprentice on the Southeastern Railway (now Canadian Pacific) at Farnham, Que. Completing his apprenticeship in 1891, he

S. J. Hungerford

worked at his trade at various places in Quebec, Ontario and Vermont for the Canadian Pacific. In 1894 he became chargeman for the same company at Windsor street, Montreal. Three years later he was promoted to the post of assistant foreman at Farnham shops. In 1900 he went to Megantic, Que., as locomotive foreman. The following year he was transferred to McAdam Junction, N. B., as general foreman. He then went to British Columbia for two years, being locomotive foreman at Cranbrook. In 1903-04 he was master mechanic for the Western division of the Canadian Pacific, with headquarters at Calgary, Alta., and in the latter year was promoted to the superintendency of the locomotive shops at Winnipeg, Man. From 1908 to 1910 he was superintendent of shops at Winnipeg. In 1910 he resigned from the service of the Canadian Pacific to become superintendent of rolling stock of the Canadian Northern (one of the predecessor companies of the present Canadian National), with headquarters at Winnipeg. In 1915 he was transferred to Toronto, Ont., in the same capacity. Two years later he became general manager of the Eastern lines of the Canadian Northern and in the following year was appointed assistant vice-president of operation, maintenance and construction of the Canadian National, then in process of formation as successor to the Canadian Northern, with the same headquarters. In 1920 he became vice-president of operation, maintenance and construction of the Canadian National and Grand Trunk Pacific. In 1922 he was appointed vice-president and general manager of the two companies and, upon their merger into the present Canadian National System in 1923, he became vice-president of operation and construction of the system with headquarters at Montreal, in which position he remained until he was chosen also as acting president of the system in 1932 when the late Sir Henry Thornton retired. On the establishment of the board of trustees on January 1, 1934, Mr. Hungerford was appointed president.

Master Mechanics and Road Foremen

W. P. Primm has been appointed assistant road foreman of engines, Baltimore division, of the Pennsylvania.

G. E. Vaughn, special duty engineman, St. Louis division, of the Pennsylvania, at Terre Haute, Ind., has been appointed assistant road foreman of engines, Fort Wayne division, with headquarters at Fort Wayne, Ind.

Obituary

John Gill, who retired in 1910 as superintendent of motive power of the Chicago, Indianapolis & Louisville, died at his home at Chicago on August 25.

Moses Burpee, consulting engineer of the Bangor & Aroostook, and formerly chief engineer of this company, died at his home at Houlton, Me., on August 18, at the age of 89 years.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

Welded Steel Truck Frames.—Lukenweld, Inc., division of Lukens Steel Company, Coatesville, Pa., describes and illustrates in an eight-page booklet welded steel truck frames for B. M. T. Lines multisection cars.

Hollow Screws.—This catalogue, issued by the Allen Mfg. Co., Hartford, Conn., undertakes to assist in applying hollow screw advantages to machines on the floor and on the drawing board, and includes views of practical uses.

Pipe Tools.—Illustrated and described in the eight-page booklet issued by the Beaver Pipe Tools, Inc., Warren, Ohio, are the Model-A "Special" and the Model-A "Standard" pipe machines, having ranges of 1/8 in. to 2 in. and 1/2 in. to 2 in., respectively.

Permutit Boiler Feedwater Treatment.—The chemicals used in Permutit internal boiler feedwater treatment and the feeds available are discussed in the eight-page booklet issued by the Permutit Company, 3320 West Forty-second street, New York.

Feedwater Heating Equipment.—The construction, operation and principal advantages of the Worthington Type SA locomotive feedwater heating equipment are described in the four-page folder issued by the Worthington Pump and Machinery Corporation, Harrison, N. J. A diagram shows the course of steam and water through the equipment.

Cranes. — The Whiting Corporation, Harvey, Ill., has issued a 24-page illustrated catalog descriptive of the Tiger type of overhead electric traveling crane.

Ajax Forging Rolls.—Bulletins 91 and 91-P issued by the Ajax Manufacturing Company, Cleveland, Ohio, illustrate and describe Ajax wide adjustment forging rolls and forging roll products.

"Operator's Instruction Book."—This book, issued by the Landis Machine Company, Waynesboro, Pa., covers the Lanco Type R heads for threading machines, the Landmatic Type F heads for turret lathes, and the Landex Type J heads for automatic screw machines. It gives detailed data for the correct grinding and setting of Landis chasers and the care and operation of the three types of die heads.

Journal Bearing Damage.—The subject of journal bearing damage, its effects and remedy, is covered in an eight-page bulletin prepared for distribution by the Lewis Bolt & Nut Company, Minneapolis, Minn. This bulletin gives in condensed form a description of the methods followed and results secured in certain tests recently conducted in the laboratory of the Railway Service & Supply Company, Indianapolis, Ind., under the direction of K. W. Brossart of the Railway Service & Supply Company and H. W. Johnson of the Lewis Bolt & Nut Company. It is claimed in the bulletin that the tests proved conclusively that major or minor damage to the linings of plain journal bearings seriously interferes with proper lubrication and as a result tends to produce hot boxes and attendant operating difficulties and delays. Part II of the bulletin shows the favorable results secured with Macer journal bearing protectors in avoiding damage to journal bearings in transit.

Railway Mechanical Engineer

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With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic. Name Registered, U. S. Patent Office

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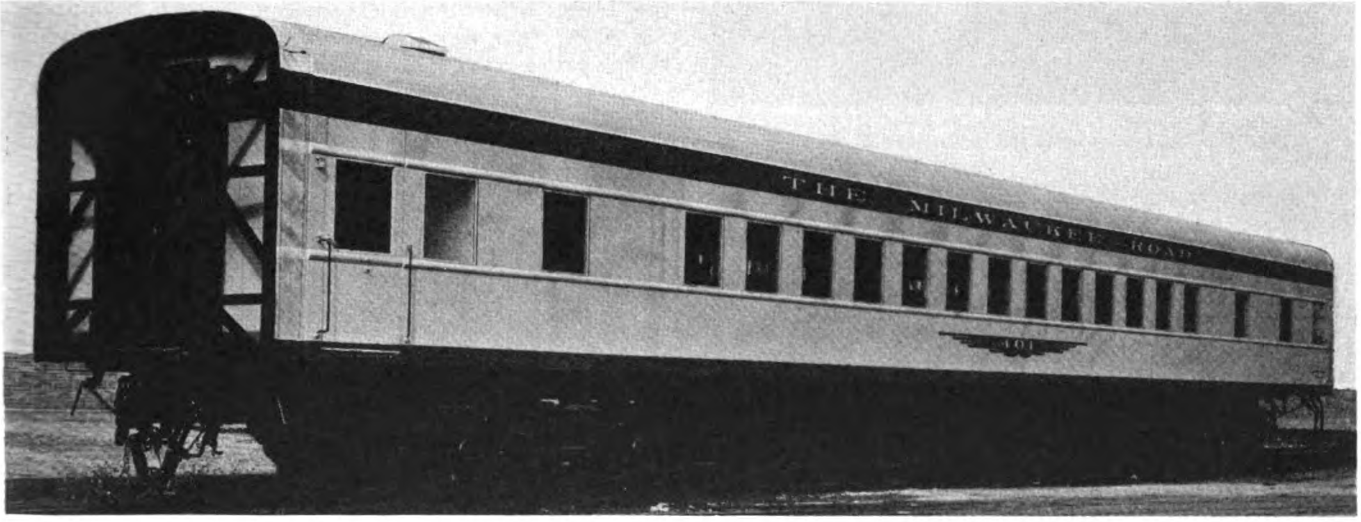
RAILWAY MECHANICAL ENGINEER

Weight Saved in

New Hiawatha Cars

The use of Cor-Ten steel in superstructures, additional aluminum alloys for interior trim and lighter couplers, draft gears and brake rigging has effected a further weight reduction of 10 per cent as compared with the welded cars first installed in this train

COMPLETE new car equipment has recently been placed in service by the Chicago, Milwaukee, St. Paul & Pacific on the Hiawatha, its light-weight, high-speed train between Chicago and the Twin Cities, Minn. Not only are the new nine-car train units lighter in individual car weight, but they have also been changed in interior arrangement to provide enlarged dining facilities and more salable passenger seats. The structural design has been based on the use of Cor-Ten steel. The cars are better insulated, the air-conditioning improved and the exterior appearance changed by tying the windows together in a longitudinal panel effect which is continuous throughout the length of the train. The equipment replaced will be used in a second section



One of 17 luxurious modern coaches recently built for use in the newly equipped Hiawatha

of the Hiawatha operating between Chicago, Milwaukee, New Lisbon and Minocqua, Wis., via the Valley division.

The new cars were designed and built at the road's Milwaukee shops and are similar in shape and general dimensions to the cars first used when the Hiawatha service was inaugurated in 1935. These cars were, in turn, similar to the all-welded, light-weight steel coach built by the C. M. St. P. & P. in 1934,* except for the inclusion of cast-steel underframe ends, the installation of double windows, changes in interior finish and decoration and the installation of air conditioning. The original cars of the Hiawatha weighed from 31 to 33 per cent less than riveted steel cars of the same capacity. By the use of Cor-Ten steel for the car superstructures, underframes and load-carrying members; by the more extensive use of aluminum alloys for interior trim, air-conditioning ducts, conduit, brake cylinders, slack adjusters, etc., and by the lightening of such parts as car floors, couplers, draft gears and brake rigging a further saving of about 10 per cent has been effected in the new cars, so that they are from 41 to 43 per cent lighter than conventional steel passenger cars.

What this weight reduction, in conjunction with roller-bearing trucks, means in the way of reduced tractive force requirements can be readily appreciated when it is observed that the same locomotive which made the high-speed schedule between Chicago and the Twin Cities with seven cars in the 1934 Hiawatha can make the same schedule with nine cars in the 1936 Hiawatha. Reference to the table shows an increase

* For a description of the original car see the *Railway Mechanical Engineer*, October, 1934, page 361, and December, 1934, page 444.

in train weight from 1,355,300 lb. to 1,408,800 lb., or only about 27 tons, in spite of the addition of two extra cars. The table also shows an increase in the number of individual seats from 376 to 464 and a decrease in car weight per individual seat from 2,146 lb. to 1,854 lb., or 13.6 per cent.

Principal Changes in the New Train

Aside from the use of Cor-Ten steel and aluminum alloys, as already described, to reduce weight, the principal changes in design of cars for the new train are: (1) the substitution of built-up welded sheet construction with stiffeners, instead of the pan construction first employed; (2) the more extensive use of spot welding in connection with arc welding for fabrication

The "Tip Top Tap" room in the forward end of the train

purposes; (3) the provision of a 10-in. H-beam for the center sill instead of a 12-in. A.A.R. section, thus giving 2 in. more rail clearance; (4) the mounting of all air-conditioning equipment, batteries, water tanks, etc., in a narrow streamlined rectangular steel shell under the center sill, thus reducing wind resistance underneath the car and lowering the center of gravity of the car† about 7 in. to a point below the floor line, or approximately 4 ft. 2 in. above the rails; (5) the provision of rubber-covered closures between the cars and retractable vestibule steps to still further accentuate the streamline effect and reduce wind resistance; (6) the entire elimination of vestibules and steps in the diner and the express tap-room car, and the provision of only one vestibule in each of the other cars.

Improvements in the air conditioning system include a certain reduction in weight in the Safety-Carrier six-ton steam-jet unit which is installed under each car, and the provision of a more compact design. Somewhat more powerful fans are used in the air distribution system and a revised double air duct arrangement provides for a more effective distribution of the conditioned air throughout the length of the various cars. The same blower is used to circulate the cooled air as is used for the heated air in the heating season. Heated air is introduced in the car body through grilles located near the floor and the cooled air through grilles located in the luggage rack near the ceiling. There are no conventional heating pipes in the body of the car. Standby or yard heat is provided by a concealed radiator in each end of the car.

† The center of gravity referred to is that of the combined car body and trucks.

The lighting equipment is also revised to a certain extent to provide increased candle power where needed, the intensity of illumination being controlled by means of lenses. In the coaches, a high intensity is obtained at the reading level with two lenses for each seat. The fixtures are located at the sides underneath the luggage rack. In the dining and tap room cars the plane of the lenses is horizontal, with the light controlled so as to produce the highest intensity of illumination on the table top, keeping all direct glare out of the eyes of the passengers.

Table I—Scale Weights of Hiawatha Trains of the C. M. St. P. & P.

	1934 Hiawatha No. of Cars	1934 Hiawatha Weight in lb.	1936 Hiawatha No. of Cars	1936 Hiawatha Weight in lb.
Express tap-room car	1	131,500	1	96,200
Coaches	4	448,800	4	379,600
Dining car	..	......	1	102,300
Parlor car	1	113,700	1	95,100
Drawing room parlor car	..	......	1	95,200
Beaver-tail parlor car	1	112,900	1	92,000
Total car weight	7	806,900	9	860,400
Locomotive weight		548,400		548,400
Total train weight		1,355,300		1,408,800
Total seating capacity		376		464
Number of salable seats		238		291
Car weight per individual seat		2,146		1,854
Car weight per salable seat		3,390		2,957
Train weight per individual seat		3,604		3,036
Train weight per salable seat		5,694		4,841

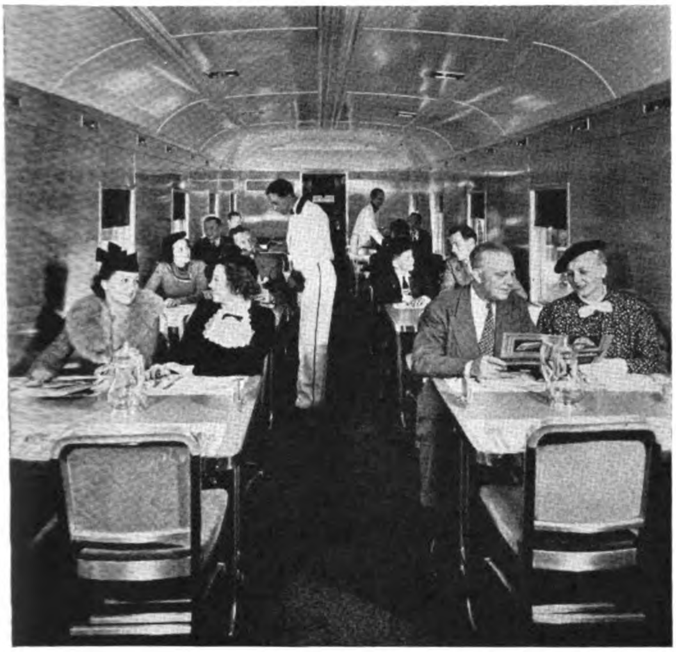
Important changes are also made in the consist of the train, which includes the express-tap room car, the diner, four new coaches, a parlor car, a drawing-room parlor car and a beaver-tail parlor car. The

One of the new coaches

dining car is located in the middle of the train instead of at the head end in combination with the tap room. The coaches have greater seating capacity and more storage space for luggage. Three parlor cars are provided instead of two and this permits reducing the size of men's and women's lounge rooms in some of the other cars.

Description of the Equipment

The 18 cars of the new Hiawatha are part of a complete order of 37 cars, just completed at Milwaukee shops, which will be used in a pool with the older cars to meet the requirements for four separate train units.



One of the large dining cars

This new equipment includes five baggage cars, five mail-express cars, two diners, two express-tap room cars, two parlor cars, two drawing-room cars, two beaver-tail parlor cars and 17 coaches. All of the cars are semi-tubular in shape with turtle-back roofs and sides curved inward slightly at the bottom. They present a flush outside surface on the sides and roof and, by provision of the full-width, rubber-covered diaphragms between cars, the train gives the appearance of a unit train without any sacrifice of interchangeability to meet varying traffic requirements. Like the preceeding lot, each new car is slightly less than 82 ft. long between coupler pulling forces and the total length of nine cars is therefore about 737 ft. The cross section dimensions are essentially the same as those given in the article describing the first welded steel car.

Particular attention has been paid to insulation and sound deadening, all interior steel surfaces being sprayed with a sound-deadening compound containing cork, with the insulation of the sides and roof applied while the sound-deadening material was still wet. It is expected that this type of construction will assist in reducing noises in the cars. The sides and roof of the cars are insulated with Dry Zero, the sides having 3 in. of insulation and the roofs 2½ in. To facilitate the application of the insulation, the material is worked up in blanket form, a separate blanket being prepared beforehand of the proper size to fit the cavities between the posts or carlines. The floors are insulated with fibre glass and here, also, the insulation is furnished cut to size for each cavity in the floor.

The four-wheel trucks, equipped with Commonwealth cast-steel frames, Timken roller-bearing and Simplex clasp brakes, represent a further refinement in design, whereby the weight is reduced from 15,195 lb. per truck in the original train to 14,513 lb. per truck in the new Hiawatha. Brake cylinders and slack adjusters are made of aluminum alloys, and brake levers are reduced in cross-section and weight wherever feasible by the use of high-tensile alloy steel. The Safety truck-mounted generator is equipped with Dayton-Roderwald V-belt drive.

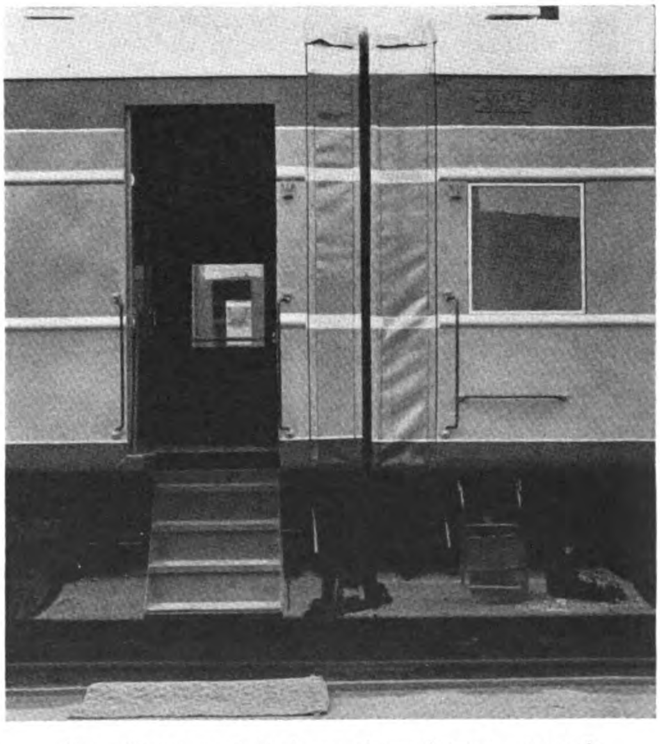
The exterior appearance of the new train is striking. Aluminum paint is used on the car roofs and the sides are in orange yellow. The top border on the sides is in maroon with an aluminum stripe separating it from the yellow of the car sides. Above and below the windows are raised moldings finished with aluminum, and near the bottom of the sides there is a silver stripe and maroon border. Housing under the cars is brown, as are the trucks. A wing design, similar to the one on the head of the locomotive, is painted on the sides of each car and in the middle of each wing the car number or name appears. On the rear of the beaver-tail car there is a wing with "Hiawatha" in the center.

Table II—Comparative Weight (In Pounds) of C. M. St. P. & P. All-Welded Passenger Coaches of 1934 and 1936

	1934	1936
Car body	72,200	56,102
Trucks*	32,800	29,026
Car weight	105,000	85,128
Air-cooling equipment	7,200	5,455*
Total car weight (including air-conditioning equipment)	112,200	91,983

* Includes heating and air-conditioning equipment.

The interior arrangement of the various cars is indicated on the floor plans. In the express-tap-room car an enclosed compartment in the forward end, 30 ft. 6 in. long, is used for through express. The tap room has a bar extending across the entire width. Bar service is available at all times enroute. There are 10 tables each seating at least four people, the capacity, therefore, being referred to as 40. However, at the circular tables six people can be seated comfortably. There is a push button at each table to summon a waiter. There are no vestibules or windows, save for a port hole on either side near the bar.

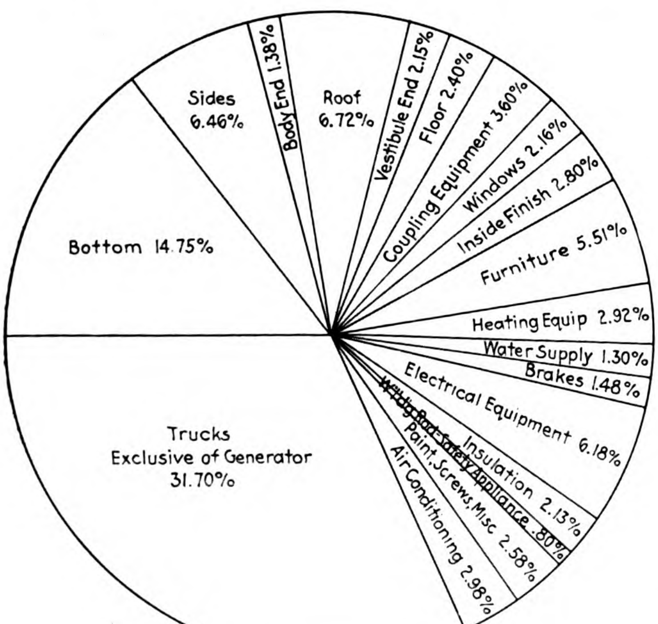


The rubber-covered diaphragm closure between cars and retractable vestibule steps

The ceiling is curved and painted a bone white. Pan-

The rear of one of the new beaver-tail parlor-observation cars

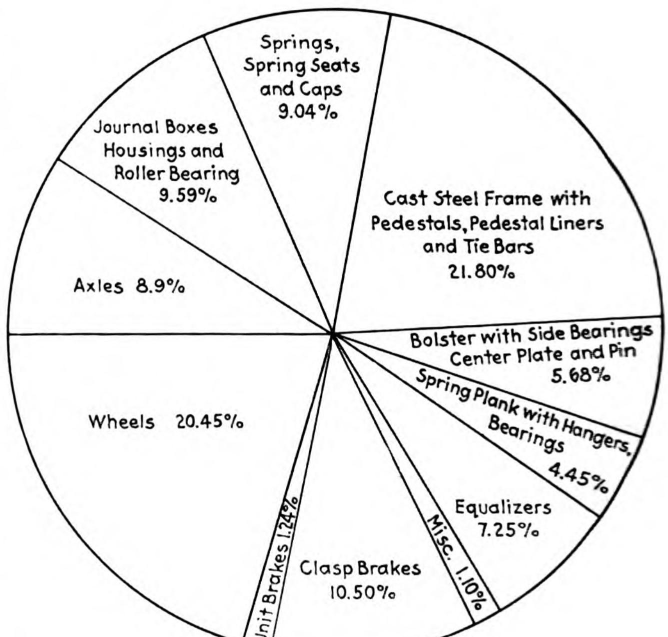
els at tables have modernistic mirrors, with a background painted peach. Panels are trimmed with stainless steel and wainscoting set off with two stainless-steel bands set in wood moulding. Moulding between the bands is painted orange. Walls surrounding the panels are painted with five shades of blue properly blended. The floors are covered with mottled grey rubber. Tables are rubber-covered and have table legs and pedestals of polished aluminum. Seats have polished aluminum frames, with seats and backs covered with red leather.



Total weight, lb.	91,983
Weight per sq. ft. floor area, lb.	128
Seating capacity	66
Weight per passenger, lb.	1,393

Distribution of the weight of the 1936 coaches

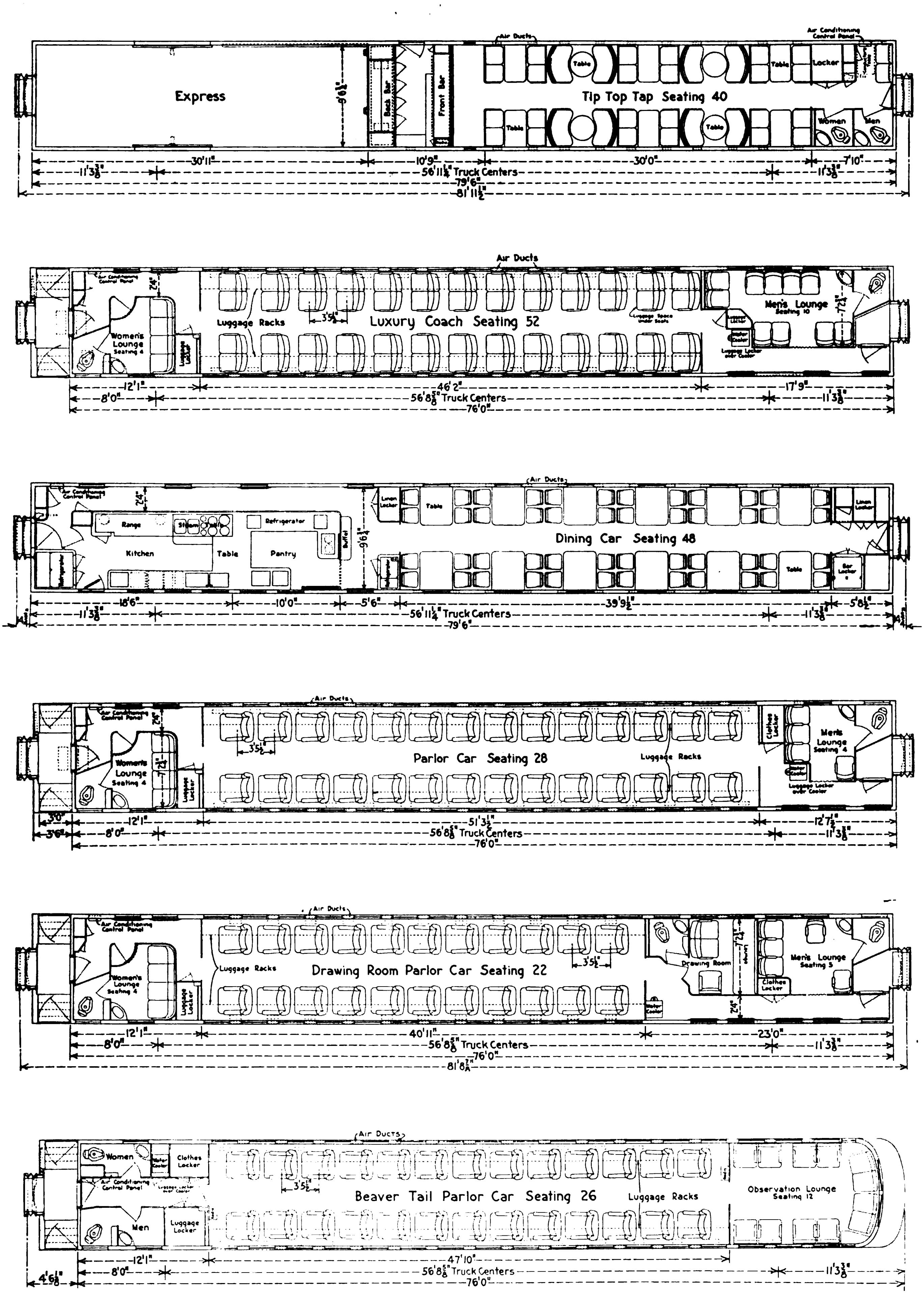
The tap room car also has a small compartment equipped with a work table for the train conductor.



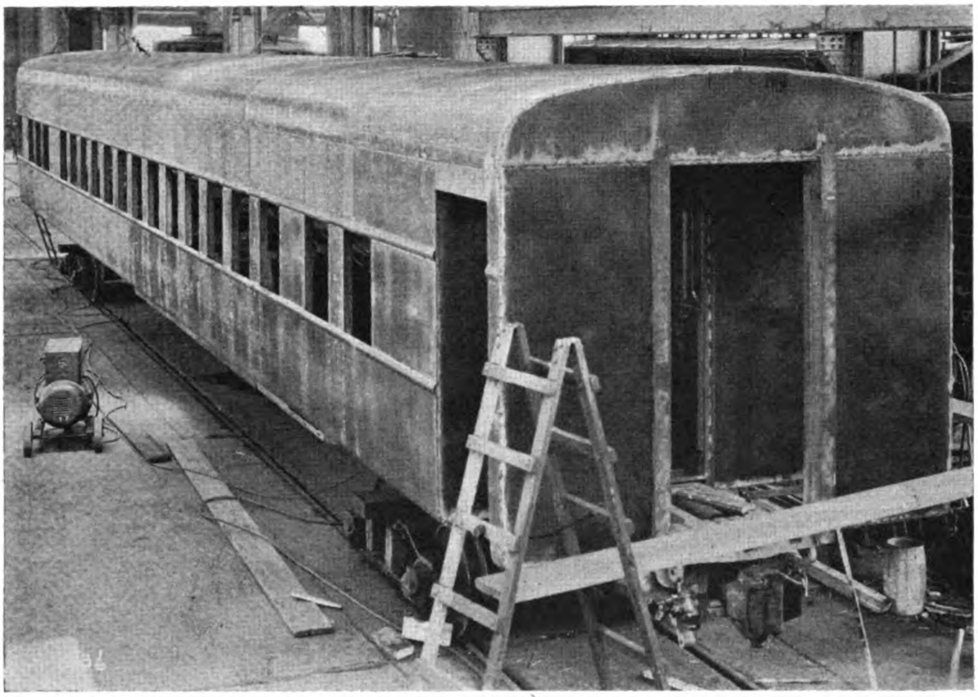
Weight with clasp brakes, unit brakes, Timken roller bearings and housings, lb.	14,513

Distribution of the weight of the 1936 four-wheel 5-in. by 9-in. cast-steel passenger truck

The coaches have vestibules at but one end; normally, the forward end. The main passenger compartment, 46 ft. 2 in. long, seats 52. The men's lounge, 14 ft. long, seats 10. The ladies' lounge, 6 ft. long, seats 4. The seats in the body of the car turn in pairs, but may be reclined separately. They are luxuriously upholstered and are spaced 3 ft. 5 in. between centers. Wide windows are placed slightly forward of the seats. Exceptionally wide overhead luggage racks extend the entire length of the car. Roomy space is available under the seats for the storage of luggage and at one end of the car there are compartments for the storage of hand



Floor plans of the types of cars used in the newly equipped Hiawatha trains

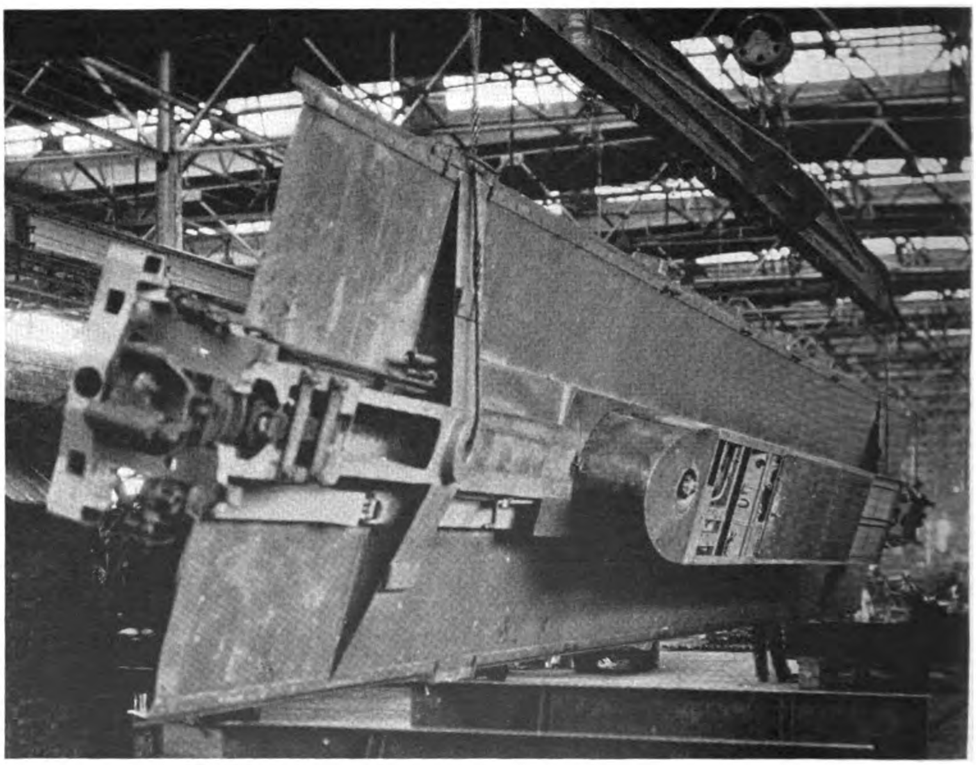


A car with the underframe sides, roof and ends assembled ready for finish welding

baggage and clothes. Electrically refrigerated water coolers are provided.

The dining car provides seats for 48, the largest capacity of any self-contained dining car unit in the country. The length of the dining compartment is 40 ft. The decorative scheme includes bone-white ceilings, silver-gray walls of imported Harewood veneer, dark blue carpeted floor. Tables are of chromium tubing with blue rubber tops; chairs of polished aluminum upholstered with coral velour. The diner is equipped with a pantry 10 ft. long and a kitchen 18 ft. 6 in. long. A specially-devised cooling system provides comfort for the kitchen crew in what would otherwise be extremely warm quarters. Fuel oil is burned in the range.

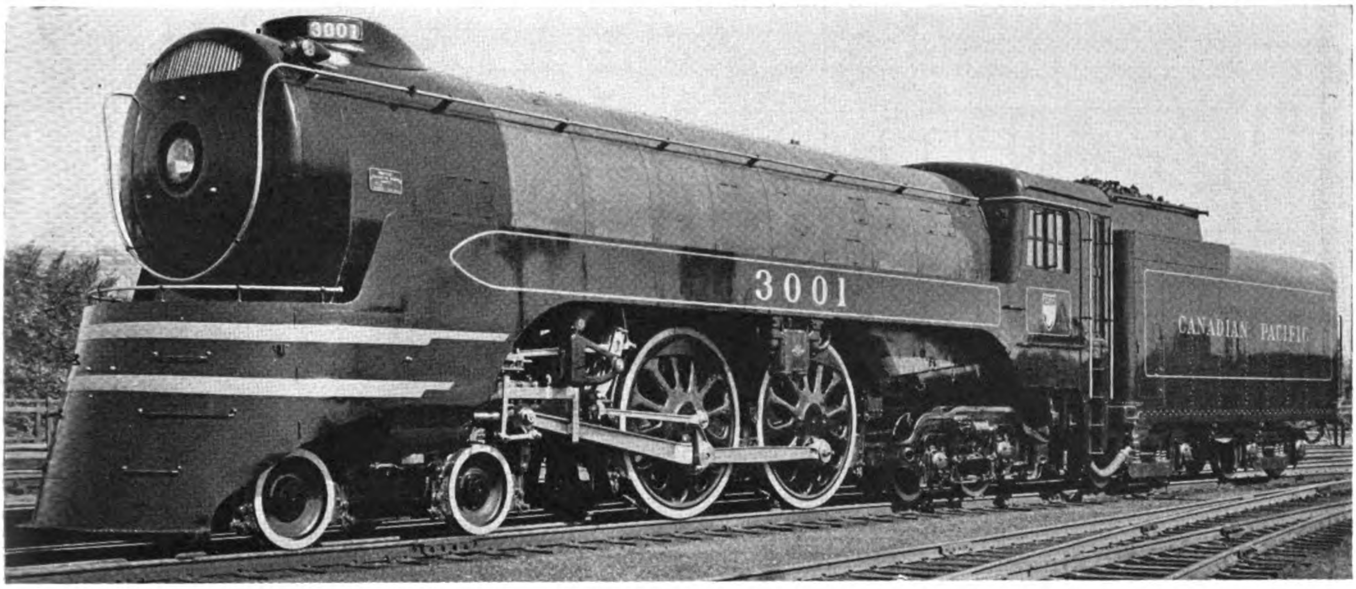
The parlor car has 28 swivel chairs in the main passenger compartment which is 51 ft. $3\frac{1}{2}$ in. long. Four seats are provided in the men's lounge and four in the ladies' lounge, each of these lounges being slightly over 6 ft. long. Adjacent to each seat in the body of the car is a small shelf or table-like arrangement that folds and fits into the wall when not required by passengers for such use as writing or holding reading



Completed underframe with all underneath parts housed in a streamline metal box under the center sill

material. All parlor cars have bone-white ceilings, walls above the window sills and ends of Avodire veneer with African mahogany wainscoting, aluminum window frames and molding. The floors are covered with carpet of two shades of blue in the body of the

(*Continued on page 477*)



Canadian Pacific locomotive for light high-speed passenger service

High-Speed

Steam Locomotive for C.P.R.

Semi-streamline 4-4-4 type has 80-in. drivers and develops 26,500 lb. tractive force. It will haul trains of new light-weight coaches, with which it will harmonize in appearance.

SINCE late in July the Canadian Pacific has received from the Montreal Locomotive Works, Ltd., five semi-streamline locomotives for high-speed passenger service. The locomotives are of the 4-4-4 type and will be used to haul trains made up of new steel passenger coaches, the weight of which has been kept low by careful designing. The total weight of the locomotive is 263,000 lb., of which 120,000 lb. is on the two pairs of drivers. The driving wheels are 80 in. in diameter, the cylinders 17¼ in. by 28 in., and, with a boiler pressure of 300 lb. per sq. in., the locomotive develops a tractive force of 26,500 lb.

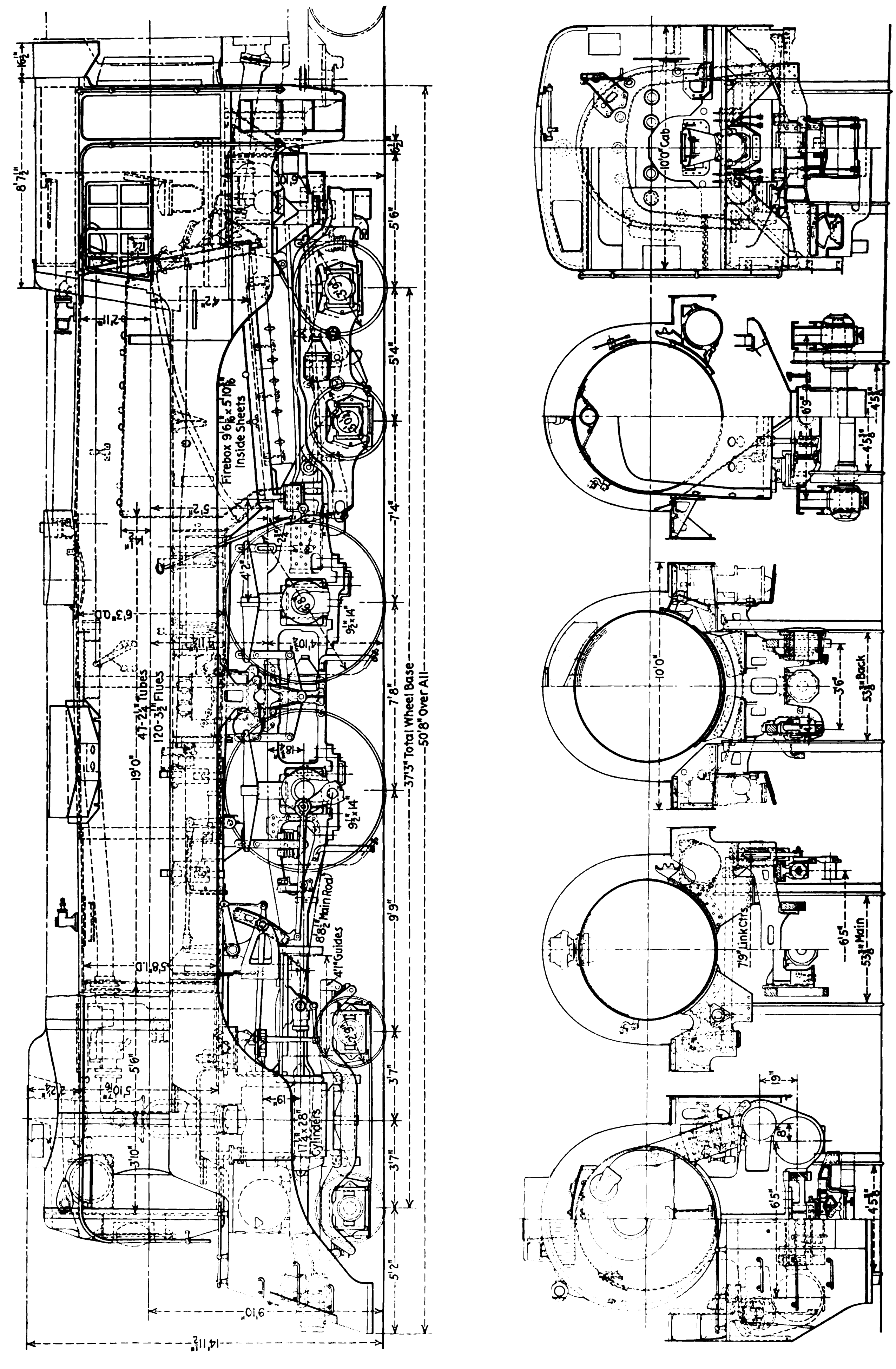
The Boiler

The boiler is of the conical type with three shell course of nickel steel. The first course is 68 in. in inside diameter, the second course is conical, and the third 75 in. in outside diameter. The first course is of 23/32-in. material; the second, of ¾-in. material, and the third, of 25/32-in. material. The firebox sheets and staybolts are also of nickel steel. There is no combustion chamber, and the length over tube sheets is 19 ft.

The boiler is built without a steam dome. An inside dry pipe, 8 in. in outside diameter, closed at the rear end and extending back about 2 ft. into the third shell course, gathers steam through a series of circumferential slots in the top surface. These slots, the length of which in horizontal projection is 4 in., have a combined area which is approximately twice the cross-sectional area of the dry pipe. It will be seen from the detailed drawing that the slotted portion of the pipe is enclosed between transverse end pieces, which extend up to and conform with the curvature of the shell courses, and flanged sides, joined to the ends by spot welding, which lie parallel to and rest upon the dry pipe. The effect of the passage thus formed on either side of the dry pipe is to spread the water-surface area over which the steam rises sufficiently to prevent the lifting of the water and to effect a much steadier level of the water in the water glass. This form of dry pipe has been developed as the result of experience during recent years on some of the largest locomotives in use on the Canadian Pacific.

In place of the dome a manhole 17½ in. in diameter is provided through the top of the third course in front of the firebox. A flanged ring provides a seat for a flat cover on which the safety valves are mounted. Threaded safety valve connections have been replaced on this road by bolting flanges with flat ground joints in order to overcome the frequent distortion of the valve seats from too severe use of the wrench. The whistle, which also has a flange base, is studded to the boiler shell immediately back of the manhole ring. The steam connection is by pipe to the side of the whistle base from the superheated-steam turret.

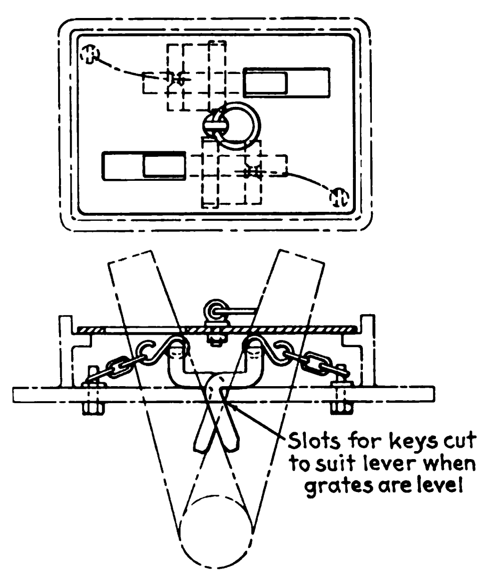
In the fabrication of the boiler shell nickel-steel rivets have been used for the first time in order to secure a higher shearing value and in order to provide a better balanced seam in the high-tensile plate. Seal welding is employed on the calking edges around the mud-ring



Elevation and cross-sections of the Canadian Pacific locomotive

corners and 10 in. up the calking edges of the vertical side- and wrapper-sheet seams. Pads for the blow-off cocks are also welded to the wrapper sheets. On the boiler shell welding is applied at the ends of the outside butt straps of the longitudinal seams. At the front end of the first course the shell seam is butt welded back for a distance of 16 in.

There are four arch tubes in the firebox. At the throat ends these are rolled and beaded into ported forged-steel sleeves which extend through the water space and are threaded and welded to the inside and outside sheets. The outer end is closed with square-threaded plugs. These have been used with success for some years on the Canadian Pacific. The grates are of the rosebud or pin-hole type and are of chromite heat-resisting steel. The side bars are closely fitted against the side sheets and the usual deflector plates are applied at the mud ring under the side carriers to deflect cold air currents inward and to prevent them from sweeping directly up along the side sheets. This has prevented trouble from firebox side sheets cracking. The ash-pan hopper and door are of cast steel, while



Method of locking and covering grate-shaker levers in the cab floor

the body of the pan is of plate construction. Drop side doors at the top of the ash pan are provided to facilitate cleaning and inspection.

The boilers are fitted with the Type E superheater, in the header of which is included the American multiple throttle. The Elesco feedwater heater is mounted in a deep recess in the top of the front end of the smokebox. The steam connections between the cylinders and the header are installed with gland-packed slip joints where the pipes are attached to the cylinders. This arrangement has overcome the considerable difficulty formerly experienced with failures of these pipes from expansion and contraction stresses. The front end is fitted with a barrel type of netting, oval in horizontal cross-section. The netting fits into grooved castings at the top and bottom and may be readily removed. This is an arrangement with which the railroad has been experimenting with considerable success during the past few years.

The stack and stack cowling form the only projection above the surface of the cowling over the boiler. The stack is of the inside extension type and at the top is enclosed by a streamline casing, the top of which is flush with the top of the stack and in which is the smoke-lifter air passage which opens upward behind the stack and has its intake through a grille in the casing over the smokebox front.

The frames are of nickel cast steel, joined at the front

General Dimensions, Weights and Proportions of the Canadian Pacific 4-4-4 Type Locomotive

Railroad	Canadian Pacific
Builder	Montreal Loco. Works
Type of locomotive	4-4-4
Road class	F-2-a
Road numbers	3000—3004
Date built	1936
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	14—11½
Height to center of boiler, ft. and in.	9—10
Width overall, in.	128⅛
Cylinder centers, in.	77
Weights in working order, lb:	
On drivers	120,000
On front truck	68,000
On trailing truck	75,000
Total engine	263,000
Tender	198,500
Wheel bases, ft. and in.:	
Driving	7—8
Front truck	7—2
Trailing truck	5—4
Engine, total	37—3
Engine and tender, total	70—8¾
Wheels, diameter outside tires, in.:	
Driving	80
Front truck	33
Trailing truck	36¼ and 45
Engine:	
Cylinders, number, diameter and stroke, in.	2—17¼ x 28
Valve gear, type	Walschaert
Valves, piston type, size, in.	9
Maximum travel, in.	6½
Steam lap, in.	1⅛
Exhaust clearance, in.	¼
Lead, in.	¼
Cut-off in full gear, per cent	84
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	300
Diameter, first ring, outside, in.	69 7/16
Diameter, largest, outside, in.	75
Firebox, length, in.	114 1/16
Firebox, width, in.	70 3/16
Height mud ring to crown sheet, back, in.	58¾
Height mud ring to crown sheet, front, in.	73
Arch tubes, number and diameter, in.	4—3½
Tubes, number and diameter, in.	47—2¼
Flues, number and diameter, in.	120—3½
Length over tube sheets, ft. and in.	19—0
Net gas area through tubes and flues, sq. ft.	6.03
Fuel	Bituminous
Stoker	Standard Type BK-1
Grate type	Rosebud
Grate area, sq. ft.	55.6
Heating surfaces, sq. ft.:	
Firebox	198
Arch tubes	34
Firebox, total	232
Tubes and flues	2,601
Evaporative, total	2,833
Superheating (Type E)	1,100
Combined evap. and superheat	3,933
Feedwater heater, type	Elesco
Tender:	
Style or type	Rectangular
Water capacity, Imperial gal.	7,000
Fuel capacity, tons	12
Trucks	Four-wheel
Journals, dia., in.	6.2992
General data, estimated:	
Rated tractive force, engine, 85 per cent, lb.	26,500
Speed at 1,000 ft. per min. piston speed, m.p.h.	51
Piston speed at 10 m.p.h., ft. per min.	196.1
R.p.m. at 10 m.p.h.	42
Equiv. evap. per sq. ft. evap. h.s. per hr.	13.3
Weight proportions:	
Weight on drivers ÷ weight, engine, per cent	45.6
Weight on drivers ÷ tractive force	4.52
Weight of engine ÷ evaporation	6.97
Weight of engines ÷ comb. heat. surface	66.87
Boiler proportions:	
Firebox heat. surface, per cent comb. heat. surface	5.89
Tube-flue heat. surface, per cent comb. heat. surface	66.13
Superheat. surface, per cent comb. heat. surface	27.96
Firebox heat. surface ÷ grate area	4.17
Tube-flue heat. surface ÷ grate area	46.78
Superheat. surface ÷ grate area	19.78
Comb. heat. surface ÷ grate area	70.73
Gas area, tube and flue ÷ grate area	0.1082
Tractive force ÷ grate area	476.61
Tractive force ÷ comb. heat. surface	6.73
Tractive force x diam. drivers ÷ comb. heat. surface	539.02

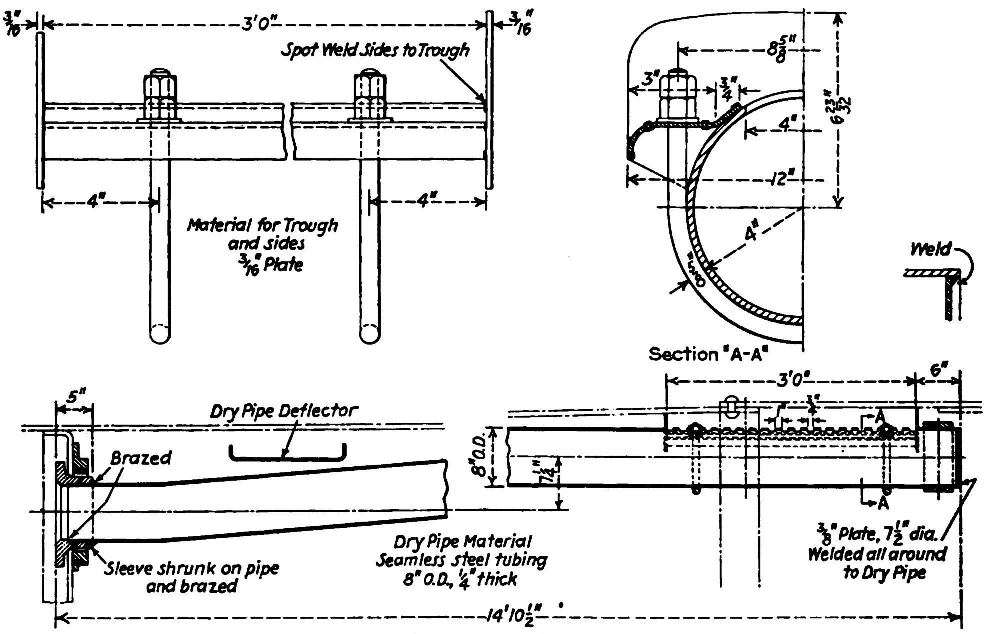
by a steel deck casting, at the rear by a General Steel Castings cradle, and by intermediate castings between the two pairs of drivers, in front of the front pair of drivers and by the guide yoke. The most important of these castings is that between the two pairs of drivers. This not only serves as a vertical crosstie and horizontal brace for the frames, but also provides a support for one of the brake cylinders and is extended upward at the ends to provide brackets for the 8½-in. cross-compound air compressor on the right side of the locomotive and the Elesco feedwater pump on the left side. These two pieces of equipment are thus placed in balance with each other and the boiler shell is relieved of the stresses caused by their direct attachment to the boiler. Both are readily accessible, removable panels being provided in the running-board skirts for this purpose.

The four-wheel engine and trailing trucks are of General Steel Castings design. Both are fitted with SKF roller bearings.

thoroughly lagged with asbestos mortar and Johns-Manville sponge blocks. The pistons are fitted with Hunt-Spiller Duplex special locked type lip rings and the valve rings are the Hunt-Spiller Duplex sectional type. The guides and crossheads are of the single-bar Dean type. The locomotives are equipped with Walschaert valve motion and Barco Type B-4 power reverse gear. The valves are 9 in. in diameter and have a maximum travel of 6½ in. They have a steam lap of 1⅛ in., an exhaust clearance of ¼ in., and are set with ¼ in. lead.

Cowling and Boiler Mountings

The streamlining consists of a cowl which completely encloses the boiler and smokebox back to the cab, with a heavily reinforced sloping shroud around the front end below the smokebox which serves as a pilot and extends around the sides to enclose the steam chests and cylinders. This is relieved by two horizontal stripes of polished metal, which conform in appearance to the polished steel of the rods and motion work. Skirts extending about 2 ft. below the running boards along the sides of the boiler conceal the piping, the reverse gear, an air reservoir on each side and (partially) the air compressor and the feed-water pump. At the rear end these blend into the sides of the cab. The front corners of the cab are rounded.



The dry-pipe installation

The driving-wheel centers are Boxpok type mounted on axles of carbon steel fitted with journal boxes of the crown-brass type. The rods are tandem type, and the distance between cylinder centers has been kept down to 77 in. Crank pins are of low carbon nickel steel with 2.5 per cent nickel and .20 to .27 per cent carbon, double heat-treated. The rods are quenched nickel-steel forgings with .32 per cent carbon and 2.5 per cent nickel.

Both pairs of main wheels are cross-counterbalanced. The amount of cross-balancing necessary, however, was reduced by the use of the tandem rods and by the fact that the main connection is on the leading driving wheels, thus greatly reducing the cylinder spread and the loads on the crank pins, wheel centers, axles and main frames because of the reduced bending movements. Contrary to the general practice in cross-counterbalancing, the Canadian Pacific does not use an offset balance weight, preferring to employ a supplementary weight set at 90 deg. to the main balance weight. In this way the balance can be readily adjusted in the event of any change in the rods or crank pins. With the customary offset in the angle of the balance weight, adjustments require a change in this angle, which is not readily effected.

The cylinders are nickel iron castings. Each cylinder and half saddle is cast as a unit. The cylinders are

The general arrangement of parts usually mounted on the boiler, with the exception of the bell, has not been greatly disturbed by the application of the lagging. The feedwater heater, the smoke stack, sand boxes, top boiler check, safety valves, whistle and steam turret are in the customary locations. The bell, however, is located on the left back steam chest cover just under the running board, and one of the three air reservoirs has been placed on the deck casting under the front end of the smokebox. The headlight generator set has been placed on the back deck casting under the floor of the cab, and the exhaust piped up through the cab to the roof. Two of the locomotives are equipped with Stone-Franklin and three with Pyle-National sets. All are 32-volt, a.c. generators.

The boiler is lagged in the usual manner. The outer casing is built with a frame of angle construction covered with a planished steel jacket. This encloses everything mounted on the upper part of the boiler, with the

exception of the smoke stack. The running board and running-board skirt are built as a part of the shroud, which is at no point rigidly attached to the boiler, but is held in lateral alignment by flexible connections to the top of the boiler. The running boards are supported from the main frames at the valve yokes and at the air-pump and feed-pump brackets. The rear end is supported from the side of the firebox by means of a sliding bracket connection which permits free movement of the boiler without strain on the running board.

The cab, except for the rounding of the corners on the front end, is essentially of standard vestibule construction in general use by the railroad. The roof ventilators have been depressed in the roof so that they are invisible from the ground. The cab is lined with Johns-Manville Flexboard.

The front of the engine is so designed that the coupler can be folded up when not in use and covered with a light removable panel. The hand-rail posts are of the Blunt type which simplify lining up the hand rail and provide for quick removal or replacement.

Brake Equipment

The locomotives are equipped with Westinghouse No. 8ET air-brake equipment with the engineer's brake valve and feed valves pedestal mounted. The engine and tender are equipped throughout with clasp brakes, with the exception of the lead wheels on the trailing truck, each of which has a single brake shoe. The engine-truck and trailing-truck brake cylinders are mounted on the trucks, two 10-in. by 10-in. cylinders on the engine truck and two 12-in. by 8-in. cylinders on the trailing truck. There are two 14-in. by 10-in. driver-brake cylinders, each operating the brake shoes on one pair of drivers. The braking ratio on the driving wheels is 80 per cent; on the rear trailing-truck wheels, 72 per cent, and on the engine and leading trailing-truck wheels, 45 per cent.

The tender is of the rectangular type, built up on a General Steel Castings water-bottom underframe. It is carried on two four-wheel trucks fitted with SKF roller bearings. The top of the tender back of the coal space is curved in at the sides to conform with the contour of the new passenger coaches with which the locomotives will be operated. The engine-tender connections include the Franklin Type E-1 radial buffer and Unit Safety type drawbars of forged nickel steel.

Finish

In finish the locomotive presents a striking appearance. The cowling about the smokebox and around the front end, and the sides and front of the cab are finished in black. The remainder of the cowling over the boiler is in planished steel. On a black field along the skirting around the running board is a wide band of Tuscan red, the standard coach color of the Canadian Pacific, which is separated from the black border by a stripe of gold. Below each cab side window is a panel of Tuscan red on which the Canadian Pacific shield is painted in colors. A large panel of Tuscan red on black is also employed on each side of the tender. The numbers and lettering are in gold.

Partial List of Specialties on the Canadian Pacific 4-4-4 Type Locomotives

Staybolts, flexible	Flannery
Trucks, Engine, trailing and tender	General Steel Castings Corp.
Driving-wheel centers (Boxpok-General Steel Castings)	Canadian Car & Foundry Co.
Driving-box cellars	Montreal Locomotive Works
Roller-bearing boxes, engine and tender	Canadian SKF Co., Ltd.
Drawbars, Unit Safety	Franklin Railway Supply Co.
Radial buffer (Type E-1)	Franklin Railway Supply Co.
Cylinder-cock operating device	T. McAvity & Sons
Cylinder-exhaust passage drain valve (World)	T. McAvity & Sons
Piston and valve rings	Hunt-Spiller
Metallic packings: Piston rod, valve stem, air compressor and steam end of feed-water pump	King type
Lubrication, motion and brake equipment	Alemite
Lubrication, main and side rod	Spee-D
Lubricators, guide bar (DV-4)	Nathan
Lubricators, flange	T. McAvity & Sons
Air brakes (Schedule 8ET)	Canadian Westinghouse Co., Ltd.
Clasp brakes, engine	American Brake Co. design
Clasp brakes, tender	American Steel Foundries
Air-compressor throttle valve	Canadian Westinghouse Co., Ltd.
Flexible coupling, steam-line	Barco Mfg. Co.
Draft gear, tender	Miner A5XB
Front cab windows (Thermosash, with Duolite glass)	Robert Mitchell Co.
Cab light (World B and C)	T. McAvity & Sons
Bell ringer (Taynold, Type B)	Railway & Engineering Specialty Corp.
Boiler blow-off cock	Everlasting Valve Model W
Throttle, multiple type	Superheater Co.
Gages: Boiler, stoker, feedwater heater	Sydney Smith
Gages: Steam-heat, signal, air-brake	Morrison
Injector, non-lifting (Hancock Type W)	T. McAvity & Sons
Injector checks	T. McAvity & Sons
Safety valves, bolted flange base	T. McAvity & Sons
Steam-heating reducing valve	Leslie Type AK
Miscellaneous valves	T. McAvity & Sons
Washout plugs	Huron type
Fire door (No. 8)	Franklin Railway Supply Co.
Grate bars and bearers, Chromite heat-resisting steel for	Hull Iron & Steel Foundry
Feedwater heater and pump (Elesco)	Superheater Co.
Power reverse gear	Barco type B-4
Tank-hose couplings	T-Z type
Tender underframe, water bottom	General Steel Castings Corp.
Classification lamp	Robert Mitchell Co.
Electric headlight (14-in. diam.)	Pyle-National Co.
Electric headlight generator	2—T. Stone & Co. 3—Pyle-National Co.

Weight Saved in New Hiawatha Cars

(Continued from page 472)

car and in the ladies' lounge; in the men's lounge with grey rubber. Seats in the body of the car are covered with turquoise green plush.

The drawing-room parlor car is similar to the straight parlor car except that a 10-ft. drawing room has been provided which reduces the seating capacity to 22 in the body of the car. The men's lounge is, however, somewhat larger than in the straight parlor car, being about two feet longer and allowing five seats instead of four. The women's lounge also seats four. A total of seven persons can be seated in the drawing room.

The beaver-tail parlor car has a vestibule at the forward end and toilet rooms, clothes lockers, and baggage lockers are contained in the first 12 ft. of the car body. The passenger compartment is 47 ft. 10 in. long with seats for 26 persons. The rear compartment of this car, an observation lounge seating 12, is materially changed from the 1934 beaver-tail. On the exterior, the rear platform is omitted and the end rounded similar to the side of the car. This has lengthened the body of the car about one foot and permits placing an additional window between the emergency side door and rear end. The number of windows in the curved section has been increased from two to four. No buffer protrudes at the rear of this car.

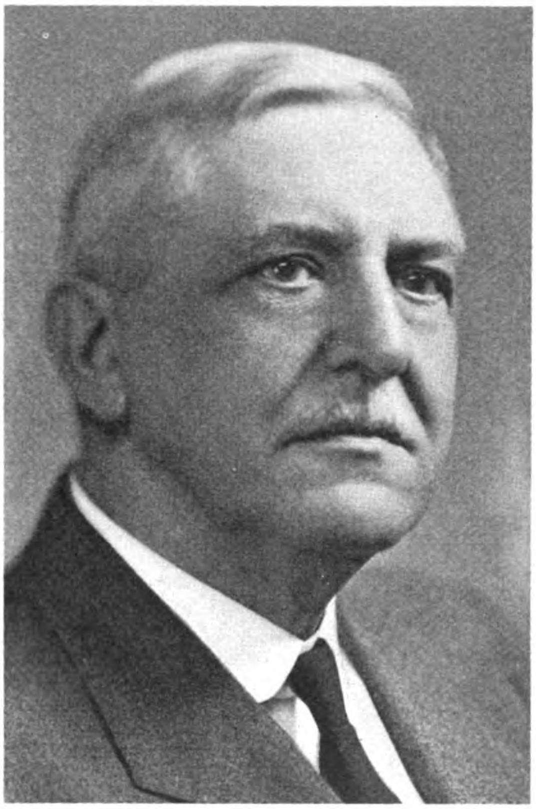
Radios are installed in the tap room and the beaver-tail cars, being of the automotive type with automotive antennae mounted on the roof. The receivers are concealed and operated by the crew, or porter, as the case may be. The tap room has one speaker concealed in the ceiling cove and the beaver-tail has two speakers, one for the body of the car and one for the rear compartment, concealed in the ceiling cove.

W. F. Kiesel, Jr., Retires

Forty-eight years with Pennsylvania in Mechanical Engineering Department

W. F. KIESEL, JR., mechanical engineer of the Pennsylvania Railroad during the past 17 years, retired from active service on September 30, 1936. His entire service of more than 48 years with that company was in the department of mechanical engineering design. For the greater part of this period he was an important factor in that department, since he was promoted to the position of chief draftsman more than 37 years ago, at about the time when interest was being stimulated in the possible use of all-steel gondola and hopper cars for the coal and ore traffic.

He took a leading and important part in steel freight car design from the very beginning. The tendency at that time was to turn out extremely light designs. Mr. Kiesel understood the importance of this from the standpoint of operating economies, but he also recognized the necessity of keeping down maintenance costs and insuring the continued serviceability of the equipment. The Pennsylvania designs were at first criticized for their strength and high weights, but in the long run they were found to be better adapted for the service and Mr. Kiesel's judgment was vindicated. His work on the Pennsylvania, and also as chairman of the Car Construction Committee of the Mechanical Division of the American Railway Association and its predecessor, during the period from 1912 to 1927, had a large influence on the improvement in the design of freight cars, not only on his own road, but on all American railroads. His contribution in the field of passenger car design was also of great importance, bridging over the period from the old all-wooden construction to the modern, all-steel construction, with the refinements and improvements which have made American passenger car service today the safest means of travel.



W. F. Kiesel, Jr.

Mr. Kiesel's contributions to the improvement in locomotive design, both steam and electric, are also of unusual value. In this development, from the old plain locomotive, as it used to be called, to the modern type, with all its refinements, Mr. Kiesel capitalized on the results of the extensive work which was done on the locomotive testing plant at Altoona, as well as facilities for making thorough and comprehensive service tests.

It is rather unusual on American railroads, for one man to have had such long and active experience in the field of equipment design, and to have exercised such a large influence not only on his own road, but upon the American railroads as a whole. In more recent years Mr. Kiesel has given much attention to the design and improvement of electric locomotives, resulting in the designs which are now operating so successfully in the New York-Washington service. Mr. Kiesel has been granted a total of 135 patents on improvements in the design of or devices for locomotives and cars. Among his more recent contributions are the limited cut-off and improvements in the design of front end drafting devices.

William Frederick Kiesel, Jr., was born at Scranton, Pa., September 1, 1866. His father, an officer of the Lackawanna Iron & Coal Company, was identified with that company for 50 years, from its very beginnings to its removal from Scranton to Buffalo, when it became known as the Lackawanna Iron & Steel Company. Mr. Kiesel attended private schools at Scranton, Pa., and served an apprenticeship in the machinist trade in the shops of the Lackawanna Iron & Coal Company. He then took a preparatory course and later entered Lehigh University, from which he was graduated in 1887 with the degree of mechanical engineer. After graduation he assisted in a test of the locomotive "H. S. Goodwin" on the Lehigh Valley Railroad. He then worked at the blast furnaces of the Lackawanna Iron & Steel Company, but on April 9, 1888, resigned to become a draftsman in the office of the mechanical engineer of the Pennsylvania at Altoona, Pa. He was promoted to chief draftsman, March 1, 1899; to assistant engineer, July 1, 1900; assistant mechanical engineer, September 1, 1902, and mechanical engineer on February 1, 1910.

Mr. Kiesel was honored by the Franklin Institute in 1928 with the George Henderson Medal. He was made an Honorary Doctor of Engineering by Lehigh University in 1928. He is a member of the American Society of Mechanical Engineers and in addition to his leadership of the Car Construction Committee of the Mechanical Division already mentioned, served as chairman of the committees on Main and Side Rods and Springs for Freight Car Trucks.

Link Motion Valve Gear

Part III

By J. Edgar Smith*

Variable lead—Limited cutoff—Reference tables giving valve settings for 8-in., 8¼-in. and 8½-in. valve travel

Sometimes it is desired to arrange for variable lead in the design of the valve gear for locomotives used in fast passenger service. By doing so, the recommended lead of 5/16 in can be provided for in running cutoff, while in full gear a lead of ⅛ in. can be obtained. This change in lead, with the same travel and lap, provides a later maximum cutoff in full gear and consequently a greater starting power.

The most commonly used method of altering the Walschaert gear to obtain variable lead is that by which the gear is laid out as usual and the lead reduced a definite amount in full gear forward by lengthening the eccentric crank (for inside admission piston valves). This delay, of course, becomes an advance in back-up motion and the lead is consequently increased instead of reduced. This is not of any great importance since the variable lead is almost never used on locomotives which are required to operate to any great extent in backing up.

There are other methods of obtaining variable lead but they all require extra parts and while they will give the same reduction in lead in full gear for either forward or backward motion, the cost and maintenance of the extra parts is hardly justifiable. For these reasons only the first mentioned method will be considered here.

In laying out the gear for variable lead, the same method as described in Part II should be followed, except that the lead should be taken at ⅜ in. After the gear has been laid out and the lengths and proportions of all the parts have been determined, the eccentric crank should be lengthened a sufficient amount, without changing the eccentric throw, to pull the valve stem back ¼ in., giving ⅛ in. lead in full gear. This can best be done on the layout. With this reduction of ¼ in. in lead in full gear, the lead will be reduced approximately 1/16 in at 25 per cent cutoff, giving 5/16 in. lead in running position.

* Lima, Ohio.

Limited Cutoff

No attempt will be made here to study the conditions which it is necessary to consider in order to determine whether or not limited cutoff is to be provided for and to what extent the maximum cutoff in full gear is to be limited. So many factors are involved that they cannot be thoroughly discussed within the limitations of this article. Also, the purpose of this article is to suggest a method of laying out the Walschaert gear to meet definite operating conditions and not to analyze the operating requirements of the locomotive as a whole. In other words, with the total weight, tractive force, driving-wheel diameter, cylinder proportions and the boiler pressure decided on and to what extent the cutoff is to be limited, we are here concerned with the

Table I—Valve Settings for 8-In. Valve Travel

With 5/16-In. Lead

Lap, in.	Max. cutoff, full gear, per cent	Port opening, in., for per cent cutoffs: Full gear	66	50	33	25	Equiv. eccentricity, in.
2 5/8	51.5	1 3/8	....	....	25/32	19/32	2 23/32
2 1/2	55.6	1 1/2	....	....	49/64	37/64	2 27/32
2 3/8	59.9	1 5/8	....	....	47/64	9/16	2 31/32
2 1/4	63.7	1 3/4	....	....	45/64	35/64	3 5/64
2 1/8	67.4	1 7/8	....	....	43/64	17/32	3 11/64
2	71.0	2	....	....	21/32	33/64	3 17/64
1 7/8	74.1	2 1/8	....	....	5/8	31/64	3 11/32
1 3/4	77.2	2 1/4	....	....	19/32	15/32	3 27/64
1 5/8	80.0	2 3/8	1 7/16	29/32	9/16	29/64	3 1/2
1 1/2	82.7	2 1/2	1 11/32	55/64	35/64	7/16	3 9/16
1 7/16	84.1	2 9/16	1 19/64	53/64	17/32	27/64	3 19/32
1 3/8	85.3	2 5/8	1 17/64	51/64	33/64	27/64	3 5/8
1 5/16	86.5	2 11/16	1 7/32	25/32	1/2	13/32	3 21/32
1 1/4	87.7	2 3/4	1 3/16	3/4	31/64	13/32	3 11/16
1 3/16	88.6	2 13/16	1 1/8	23/32	31/64	25/64	3 45/64
1 1/8	89.7	2 7/8	1 5/64	45/64	15/32	25/64	3 47/64

With 3/16-In. Lead

Lap, in.	Max. cutoff, full gear per cent	Port opening, in., for per cent cutoffs: Full gear	66	50	33	25	Equiv. eccentricity, in.
2 3/4	49.4	1 1/4	....	....	23/32	17/32	2 23/32
2 5/8	53.7	1 3/8	....	....	11/16	33/64	2 27/32
2 1/2	57.7	1 1/2	....	....	43/64	1/2	2 31/32
2 3/8	61.9	1 5/8	....	....	21/32	31/64	3 5/64
2 1/4	65.6	1 3/4	....	....	5/8	15/32	3 11/64
2 1/8	69.1	1 7/8	....	....	19/32	7/16	3 17/64
2	72.5	2	....	....	9/16	27/64	3 11/32
1 7/8	75.6	2 1/8	....	....	35/64	13/32	3 27/64
1 3/4	78.6	2 1/4	....	....	33/64	25/64	3 1/2
1 5/8	81.4	2 3/8	1 21/64	13/16	31/64	3/8	3 9/16
1 1/2	84.1	2 1/2	1 5/16	3/4	29/64	11/32	3 5/8
1 7/16	85.4	2 9/16	1 17/64	47/64	7/16	11/32	3 21/32
1 3/8	86.5	2 5/8	1 15/64	45/64	27/64	21/64	3 11/16
1 5/16	87.6	2 11/16	1 3/16	43/64	27/64	21/64	3 45/64
1 1/4	88.7	2 3/4	1 9/64	21/32	13/32	5/16	3 47/64
1 3/16	89.9	2 13/16	1 3/32	5/8	25/64	5/16	3 49/64

With 1/4-In. Lead

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 5/8	52.6	1 3/8	....	....	3/4	9/16	2 25/32
2 1/2	56.8	1 1/2	....	....	23/32	35/64	2 29/32
2 3/8	60.9	1 5/8	....	....	11/16	33/64	3 1/64
2 1/4	64.7	1 3/4	....	....	43/64	1/2	3 1/8
2 1/8	68.2	1 7/8	....	....	41/64	31/64	3 7/32
2	71.6	2	....	....	39/64	15/32	3 5/16
1 7/8	75.0	2 1/8	....	....	37/64	29/64	3 25/64
1 3/4	77.9	2 1/4	....	....	35/64	7/16	3 15/32
1 5/8	80.9	2 3/8	1 3/8	55/64	17/32	13/32	3 17/32
1 1/2	83.6	2 1/2	1 21/64	13/16	1/2	25/64	3 19/32
1 7/16	84.7	2 9/16	1 9/32	25/32	31/64	25/64	3 5/8
1 3/8	86.0	2 5/8	1 1/4	3/4	15/32	3/8	3 21/32
1 5/16	87.2	2 11/16	1 13/64	47/64	15/32	23/64	3 11/16
1 1/4	88.3	2 3/4	1 5/32	45/64	29/64	23/64	3 45/64
1 3/16	89.4	2 13/16	1 7/64	43/64	7/16	11/32	3 47/64

With 1/8-In. Lead

Lap, in.	Max. cutoff, full gear per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 3/4	50.6	1 1/4	....	....	11/16	1/2	2 25/32
2 5/8	54.9	1 3/8	....	....	21/32	31/64	2 29/32
2 1/2	58.8	1 1/2	....	....	41/64	15/32	3 1/64
2 3/8	62.9	1 5/8	....	....	39/64	7/16	3 1/8
2 1/4	66.6	1 3/4	....	....	37/64	27/64	3 7/32
2 1/8	70.0	1 7/8	....	....	35/64	13/32	3 5/16
2	73.5	2	....	....	17/32	25/64	3 25/64
1 7/8	76.5	2 1/8	....	....	1/2	23/64	3 15/32
1 3/4	79.4	2 1/4	....	....	15/32	11/32	3 17/32
1 5/8	82.2	2 3/8	1 17/64	49/64	7/16	21/64	3 19/32
1 1/2	84.8	2 1/2	1 19/64	23/32	13/32	5/16	3 21/32
1 7/16	86.0	2 9/16	1 1/4	11/16	13/32	19/64	3 11/16
1 3/8	87.2	2 5/8	1 13/64	21/32	25/64	19/64	3 45/64
1 5/16	88.3	2 11/16	1 5/32	5/8	3/8	9/32	3 47/64
1 1/4	89.4	2 3/4	1 1/8	39/64	23/64	17/64	3 49/64

valve events which will achieve the best possible performance under these conditions.

The method of determining valve characteristics as described in Part I and the method of laying out the

Table II—Valve Settings for 8¼-In. Valve Travel

With 5/16-In. Lead

Port opening, in., for per cent cutoffs

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 3/4	50.2	1 3/8	....	....	13/16	39/64	2 49/64
2 5/8	54.6	1 1/2	....	....	25/32	19/32	2 57/64
2 1/2	58.5	1 5/8	....	....	49/64	37/64	3 1/64
2 3/8	62.3	1 3/4	....	....	47/64	9/16	3 1/8
2 1/4	66.2	1 7/8	....	....	45/64	35/64	3 15/64
2 1/8	69.5	2	....	....	43/64	17/32	3 21/64
2	72.8	2 1/8	....	....	21/32	33/64	3 27/64
1 7/8	75.9	2 1/4	....	....	5/8	31/64	3 1/2
1 3/4	78.7	2 3/8	....	....	19/32	15/32	3 37/64
1 5/8	81.3	2 1/2	1 7/16	29/32	9/16	29/64	3 41/64
1 1/2	84.0	2 5/8	1 11/32	55/64	35/64	7/16	3 45/64
1 7/16	85.0	2 11/16	1 19/64	53/64	17/32	27/64	3 47/64
1 3/8	86.3	2 3/4	1 17/64	51/64	33/64	27/64	3 49/64
1 5/16	87.4	2 13/16	1 7/32	25/32	1/2	13/32	3 51/64
1 1/4	88.4	2 7/8	1 3/16	3/4	31/64	13/32	3 53/64
1 3/16	89.5	2 15/16	1 1/8	23/32	31/64	25/64	3 27/32

With 1/4-In. Lead

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 3/4	51.3	1 3/8	....	....	49/64	37/64	2 53/64
2 5/8	55.7	1 1/2	....	....	3/4	9/16	2 61/64
2 1/2	59.5	1 5/8	....	....	23/32	35/64	3 5/64
2 3/8	63.3	1 3/4	....	....	11/16	33/64	3 3/16
2 1/4	66.9	1 7/8	....	....	43/64	1/2	3 9/32
2 1/8	70.4	2	....	....	41/64	31/64	3 3/8
2	73.5	2 1/8	....	....	39/64	15/32	3 29/64
1 7/8	76.7	2 1/4	....	....	37/64	29/64	3 35/64
1 3/4	79.4	2 3/8	....	....	35/64	7/16	3 39/64
1 5/8	82.1	2 1/2	1 3/8	55/64	17/32	13/32	3 43/64
1 1/2	84.6	2 5/8	1 21/64	13/16	1/2	25/64	3 47/64
1 7/16	85.7	2 11/16	1 9/32	25/32	31/64	25/64	3 49/64
1 3/8	86.9	2 3/4	1 1/4	3/4	15/32	3/8	3 51/64
1 5/16	88.0	2 13/16	1 13/64	47/64	15/32	23/64	3 53/64
1 1/4	89.0	2 7/8	1 5/32	45/64	29/64	23/64	3 27/32
1 3/16	90.0	2 15/16	1 7/64	43/64	7/16	11/32	3 55/64

With 3/16-In. Lead

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 3/4	52.5	1 3/8	....	....	23/32	17/32	2 57/64
2 5/8	56.8	1 1/2	....	....	11/16	33/64	3 1/64
2 1/2	60.6	1 5/8	....	....	43/64	1/2	3 1/8
2 3/8	64.3	1 3/4	....	....	21/32	31/64	3 15/64
2 1/4	68.0	1 7/8	....	....	5/8	15/32	3 21/64
2 1/8	71.4	2	....	....	19/32	7/16	3 27/64
2	74.4	2 1/8	....	....	9/16	27/64	3 1/2
1 7/8	77.5	2 1/4	....	....	35/64	13/32	3 37/64
1 3/4	80.1	2 3/8	....	....	33/64	25/64	3 41/64
1 5/8	82.7	2 1/2	1 21/64	13/16	31/64	3/8	3 45/64
1 1/2	85.2	2 5/8	1 5/16	3/4	29/64	11/32	3 49/64
1 7/16	86.3	2 11/16	1 17/64	47/64	7/16	11/32	3 51/64
1 3/8	87.5	2 3/4	1 15/64	45/64	27/64	21/64	3 53/64
1 5/16	88.6	2 13/16	1 3/16	43/64	27/64	21/64	3 27/32
1 1/4	89.5	2 7/8	1 9/64	21/32	13/32	5/16	3 55/64

With 1/8-In. Lead

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 3/4	53.7	1 3/8	....	....	11/16	1/2	2 61/64
2 5/8	57.9	1 1/2	....	....	21/32	31/64	3 5/64
2 1/2	61.7	1 5/8	....	....	41/64	15/32	3 3/16
2 3/8	65.4	1 3/4	....	....	39/64	7/16	3 9/32
2 1/4	69.0	1 7/8	....	....	37/64	27/64	3 3/8
2 1/8	72.2	2	....	....	35/64	13/32	3 29/64
2	75.3	2 1/8	....	....	17/32	25/64	3 35/64
1 7/8	78.3	2 1/4	....	....	1/2	23/64	3 39/64
1 3/4	81.0	2 3/8	....	....	15/32	11/32	3 43/64
1 5/8	83.4	2 1/2	1 17/64	49/64	7/16	21/64	3 47/64
1 1/2	85.8	2 5/8	1 19/64	23/32	13/32	5/16	3 51/64
1 7/16	87.0	2 11/16	1 1/4	11/16	13/32	19/64	3 53/64
1 3/8	88.2	2 3/4	1 13/64	21/32	25/64	19/64	3 27/32
1 5/16	89.2	2 13/16	1 5/32	5/8	3/8	9/32	3 55/64
1 1/4	90.0	2 7/8	1 1/8	39/64	23/64	17/64	3 57/64

gear as described in Part II may be used for the limited-cutoff design as well as the full-cutoff design. However, it will be found that, with the maximum cutoff in full gear limited to around 60 per cent, a large link circle diameter (18 in. to 19 in.) will be necessary and it will be necessary to use the full 45 deg. link throw. Also, owing to the fact that the greater portion of the valve movement is derived from the effect of the combination lever, it will be found that the angle formed by the combination lever in its extreme positions, with the radius rod in mid position on the link, will be somewhat less than the limit of 60 deg. It is advisable, therefore, to lay off the lap plus lead plus 1/32 in. each side of the center of the valve-stem crosshead and through these points and the bottom connections of the combination lever which were located as described in Fig. 7, draw center lines which will intersect above the center of the valve stem. The distance a should be taken from this layout rather than calculated according to the formula.*

To aid in the selection of the valve events for the locomotive under consideration, the tables of maximum

Table III—Valve Settings for 8½-In. Valve Travel

With 5/16-In. Lead

Port opening, in., for per cent cutoffs

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 3/4	53.0	1 1/2	....	....	13/16	39/64	2 15/16
2 5/8	57.0	1 5/8	....	....	25/32	19/32	3 3/64
2 1/2	61.0	1 3/4	....	....	49/64	37/64	3 3/16
2 3/8	64.6	1 7/8	....	....	47/64	9/16	3 19/64
2 1/4	68.0	2	....	....	45/64	35/64	3 25/64
2 1/8	71.4	2 1/8	....	....	43/64	17/32	3 31/64
2	74.2	2 1/4	....	....	21/32	33/64	3 9/16
1 7/8	77.4	2 3/8	....	....	5/8	31/64	3 41/64
1 3/4	79.9	2 1/2	....	....	19/32	15/32	3 23/32
1 5/8	82.4	2 5/8	1 7/16	29/32	9/16	29/64	3 25/32
1 1/2	84.8	2 3/4	1 11/32	55/64	35/64	7/16	3 27/32
1 7/16	85.9	2 13/16	1 19/64	53/64	17/32	27/64	3 7/8
1 3/8	87.0	2 7/8	1 17/64	51/64	33/64	27/64	3 29/32
1 5/16	88.0	2 15/16	1 7/32	25/32	1/2	13/32	3 59/64
1 1/4	89.1	3	1 3/16	3/4	31/64	13/32	3 61/64
1 3/16	90.0	3 1/16	1 1/8	23/32	31/64	25/64	3 63/64

With 1/4-In. Lead

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 7/8	50.1	1 3/8	....	....	51/64	19/32	2 7/8
2 3/4	54.2	1 1/2	....	....	49/64	37/64	3 1/64
2 5/8	58.2	1 5/8	....	....	3/4	9/16	3 1/8
2 1/2	62.1	1 3/4	....	....	23/32	35/64	3 15/64
2 3/8	65.4	1 7/8	....	....	11/16	33/64	3 11/32
2 1/4	68.8	2	....	....	43/64	1/2	3 7/16
2 1/8	72.0	2 1/8	....	....	41/64	31/64	3 17/32
2	75.1	2 1/4	....	....	39/64	15/32	3 39/64
1 7/8	78.0	2 3/8	....	....	37/64	29/64	3 11/16
1 3/4	80.6	2 1/2	....	....	35/64	7/16	3 3/4
1 5/8	83.0	2 5/8	1 3/8	55/64	17/32	13/32	3 13/16
1 1/2	85.4	2 3/4	1 21/64	13/16	1/2	25/64	3 7/8
1 7/16	86.6	2 13/16	1 9/32	25/32	31/64	25/64	3 29/32
1 3/8	87.5	2 7/8	1 1/4	3/4	15/32	3/8	3 59/64
1 5/16	88.6	2 15/16	1 13/64	47/64	15/32	23/64	3 61/64
1 1/4	89.6	3	1 5/32	45/64	29/64	23/64	3 63/64

With 3/16-In. Lead

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 7/8	51.2	1 3/8	....	....	3/4	9/16	2 15/16
2 3/4	55.2	1 1/2	....	....	23/32	17/32	3 5/64
2 5/8	59.0	1 5/8	....	....	11/16	33/64	3 3/16
2 1/2	63.0	1 3/4	....	....	43/64	1/2	3 19/64
2 3/8	66.3	1 7/8	....	....	21/32	31/64	3 25/64
2 1/4	69.6	2	....	....	5/8	15/32	3 31/64
2 1/8	72.8	2 1/8	....	....	19/32	7/16	3 9/16
2	75.9	2 1/4	....	....	9/16	27/64	3 41/64
1 7/8	78.8	2 3/8	....	....	35/64	13/32	3 23/32
1 3/4	81.2	2 1/2	....	....	33/64	25/64	3 25/32
1 5/8	83.7	2 5/8	1 21/64	13/16	31/64	3/8	3 27/64
1 9/16	84.8	2 11/16	1 3/8	25/32	15/32	23/64	3 7/8
1 1/2	86.0	2 3/4	1 5/16	3/4	29/64	11/32	3 29/32
1 7/16	87.2	2 13/16	1 17/64	47/64	7/16	11/32	3 59/64
1 3/8	88.2	2 7/8	1 15/64	45/64	27/64	21/64	3 61/64
1 5/16	89.1	2 15/16	1 3/16	43/64	27/64	21/64	3 63/64
1 1/4	90.0	3	1 9/64	21/32	13/32	5/16	4

With 1/8-In. Lead

Lap, in.	Max. cutoff, full gear, per cent	Full gear	66	50	33	25	Equiv. eccentricity, in.
2 7/8	52.2	1 3/8	....	....	23/32	33/64	3 1/64
2 3/4	56.2	1 1/2	....	....	11/16	1/2	3 1/8
2 5/8	60.0	1 5/8	....	....	21/32	31/64	3 15/64
2 1/2	63.6	1 3/4	....	....	41/64	15/32	3 11/32
2 3/8	67.3	1 7/8	....	....	39/64	7/16	3 7/16
2 1/4	70.4	2	....	....	37/64	27/64	3 17/32
2 1/8	73.6	2 1/8	....	....	35/64	13/32	3 39/64
2	76.5	2 1/4	....	....	17/32	25/64	3 11/16
1 7/8	79.4	2 3/8	....	....	1/2	23/64	3 3/4
1 3/4	81.8	2 1/2	....	....	15/32	11/32	3 13/16
1 5/8	84.3	2 5/8	1 17/64	49/64	7/16	21/64	3 7/8
1 9/16	85.4	2 11/16	1 7/32	47/64	7/16	5/16	3 29/32
1 1/2	86.5	2 3/4	1 19/64	23/32	13/32	5/16	3 59/64
1 7/16	87.5	2 13/16	1 1/4	11/16	13/32	19/64	3 61/64
1 3/8	88.6	2 7/8	1 13/64	21/32	25/64	19/64	3 63/64
1 5/16	89.6	2 15/16	1 5/32	5/8	3/8	9/32	4

cutoffs in full gear, port openings for the different running cutoff positions according to the class of service and the equivalent eccentricity are shown for the valve travels of 8 in., 8¼ in. and 8½ in.

* See page 427 of the October, 1936, issue of the *Railway Mechanical Engineer*.

'ailures of

Locomotive Parts*

By F. H. Williams†

[t is said that "cranks make the world go 'round'." ;ertainly they make the wheels go around on a locomotive, although the crank has been made such an inrinsic part of the wheel center that it is hardly noticed)y the average person. The crank pin is the connecting ink, or one of the connecting links between the steam power and the body of the locomotive, which hauls passengers and freight over this vast continent. The power given up in the expansion of the steam forces the piston to and fro in the cylinder. This, in turn, through the piston rod, forces the crosshead back and forth, and through the rods and crank pins, drives the locomotive wheels around and the locomotive starts off on its journey.

While the other parts of the locomotive all have their special functions to perform, the crank pin is of primary importance. When it fails the locomotive stops—either on the track or in the ditch. The crank pin is a round shaft with several reductions in diameter; it is of comparatively short length, depending upon its location and the size of the locomotive. One end is pressed into the wheel center and the other is turned to suitable diameters and arranged with various devices for keeping the rods in place on the outer portion of the pin. In this article, while some of the statements are applicable to the entire pin, we shall confine our attention largely to that portion of the crank pin in the wheel center, and adjacent to the main side rod fit of the crank pin.

There are two types of failures of this portion of the pin: (1) those that fail in the wheel center, and (2) those that fail in the fillet next to the wheel fit. Failures due to defects in the steel, its composition and heat treatment, are comparatively rare and will not be considered in this article.

Failures in the Wheel Fit

Many failures of crank pins occur in the wheel fit, and usually the nature of these fractures is such as to bewilder the uninitiated. For instance, the fractured end may show one-half of coarse texture and the other half of fine texture; it would appear at first glance that the grain of one-half of the steel was fine and the other half coarse, whereas the steel is generally actually uniform in structure—either coarse or fine. Then, again, one part of the fracture may appear very dark and rusty, whereas the balance is bright. This would seem to indicate that the steel has a flaw to the extent of the dark area, but this conclusion is wrong. Possibly we can better understand the nature of a fatigue crack by outlining a few well known definitions of terms used in connection with it.

Endurance Limit.—The maximum stress to which material may be subjected an indefinitely large number of times without causing failure.

Yield Point.—The stress corresponding to some definite, permanent deformation of the steel.

Fatigue.—It has been found that for all materials failure can be brought about by the application of a load less than the static elastic limit, provided the stress is repeated often enough.

Fatigue Cracks.—Cracks due to fatigue.

Stress-Corrosion Cracks.—Cracks due to a combination of stresses (reverse) and corrosion.

In previous articles we have illustrated many fatigue cracks of side rods and driving wheel tires and have pointed out that the fine part of the fracture is the result of a crack starting from minute beginnings and working slowly across the section; it becomes coarser as it progresses and the section which finally gives way is quite coarse in structure. The fine, dark surface is caused by the ends of the cracked portion rubbing together and literally polishing themselves on each other. This surface becomes slightly corroded and darkens, so that the uninitiated is led to believe that the part has a flaw in it, whereas, in fact, the failure is caused by a fatigue crack starting from a small tool or other mark, developing gradually and finally resulting in the complete fracture. It will be found that the steel has not been stressed beyond the elastic limit or yield point, but that the fatigue crack was caused by the reverse stresses to which the steel is subjected. Examinations under the microscope fail to reveal any deformation in the grain structure, yet the crack caused by reverse stresses has advanced steadily across the section.

Tests for the endurance limit of a steel are made with highly polished specimens; in the case of ordinary carbon crank pin steel, the endurance limit runs about 40,000 lb. per sq. in., or possibly a little lower, perhaps 36,000 lb. per sq. in. Let us not forget, however, that the endurance test was made on a highly polished test specimen. Roughly, it may be stated that a tool mark 1/64 in. deep will cut the endurance limit to 50 per cent of its proper value, or, say, around 18,000 lb.; corrosion also will cause similar results. With this as a backgrounds, let us examine some typical fractures of crank pins.

One Type of Failure

The fracture end of a crank pin that failed in service is shown in Fig. 1. The upper part of the fracture, about one-third of the total cross section area of the pin, is polished, and the lower part is coarse. The polished area represents the fatigue crack proper and the coarser part indicates the more rapid extension of the crack and the final break when the steel had reached a stress greater than its elastic limit and the strength of the remainder of the metal in line with the fracture. It will be noted that the edges of the fracture in the starting of the fatigue crack at the top, are frilled, which indicates that the fracture started from a series of small cracks, all on different planes, eventually uniting into one large fatigue crack, the progressive lines of which and the path of which are shown in the illustration.

The finish of the wheel fit of this crank pin is shown in Fig. 2. This illustration is magnified, but the tool marks on the specimen are quite pronounced. The pin was applied August 28, 1934, and failed May 10, 1936, after a service of about 106,732 miles. It would not be strictly correct to say that it failed because of the tool marks, nor would it be correct to say that it failed from stress-corrosion cracks. Yet it is certain that one or the other, or both, caused the starting of the fatigue crack which resulted in the final failure of the pin.

I believe that many times this mileage can be obtained with a properly finished crank pin. Between 500,000 and 1,000,000 miles is a reasonable service requirement, and yet here is a case where complete failure occurred

* Articles on failures of side rods and tires appeared in the *Railway Mechanical Engineer* for May, June, July and October of the current year.
† Assistant test engineer, Canadian National Railways.

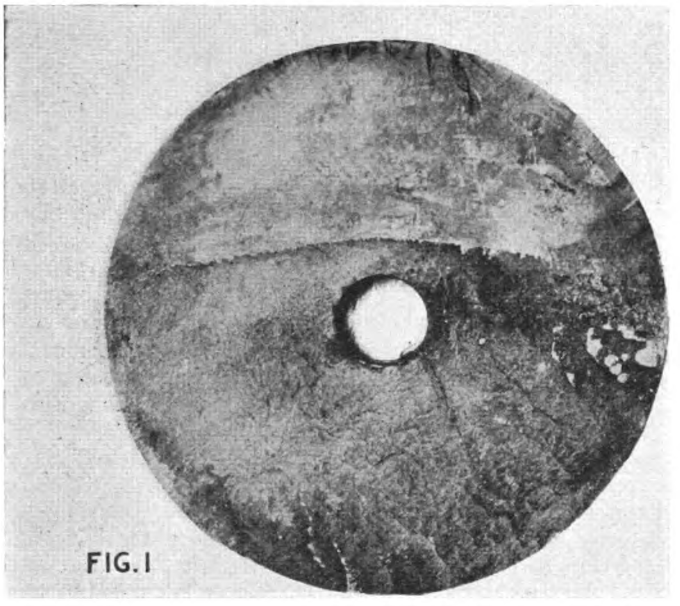


FIG. 1

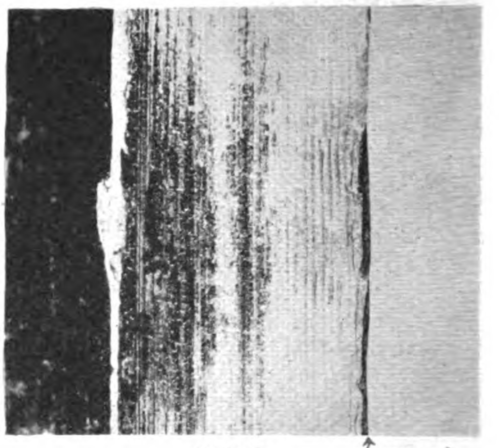


FIG. 2

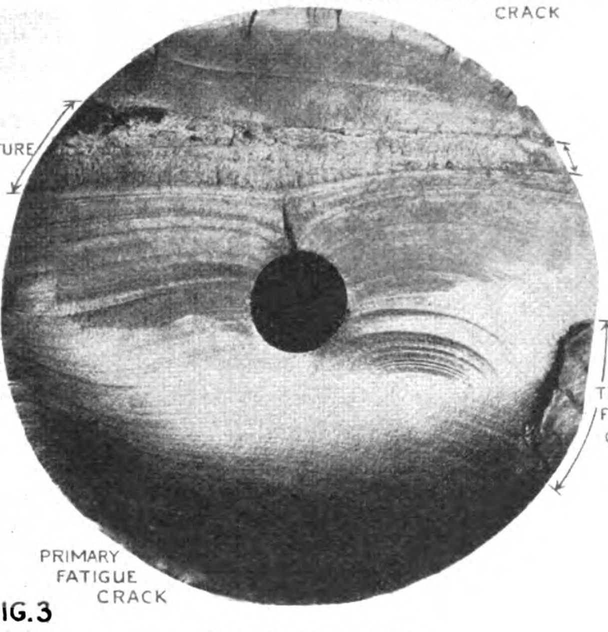


FIG. 3

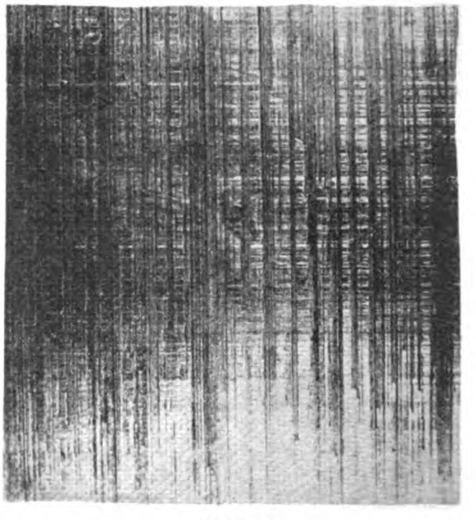


FIG. 4

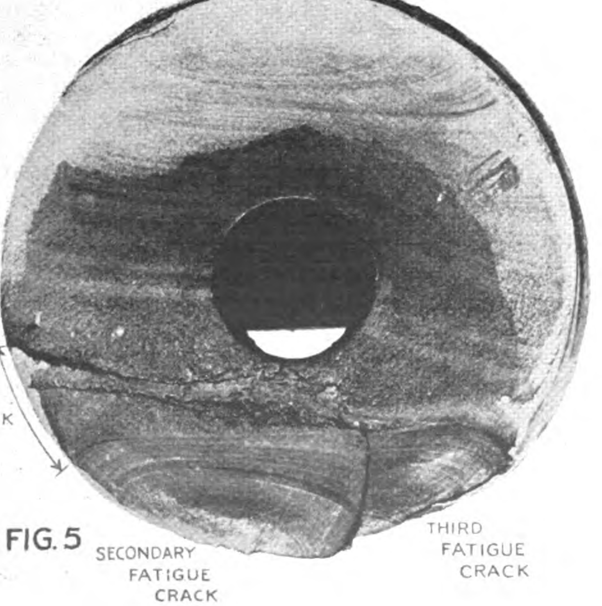


FIG. 5

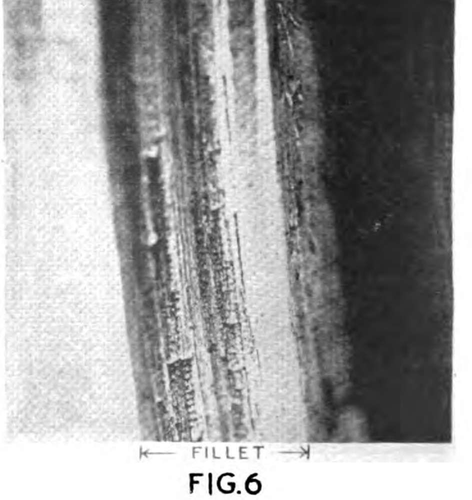


FIG. 6

at a little more than 100,000 miles. I am sure that even this low limit was high before attention was given to turning the pins with a better finish.

We have two things to contend with—rough finish and corrosion. Exactly what can we do to overcome them? Many suggestions have been tried, but the writer advocates the use of a method which he believes originated in Germany. It is by undercutting the surface of the crank pin in the wheel fit from .003 to .005, for perhaps ¼ in to ½ in. in width, or several undercuts of shorter width, the extent of the undercutting to depend upon the design.

The rolling of the surface of the metal on the wheel fit is advocated by some authorities. With this process the wheel fit is prepared by machining or grinding, or both, and is then rolled for its full length. This is an improvement, but I believe the undercutting will be better; or if the rolling is limited to the same widths as the undercutting, it might be a step in the right direction and possibly be an improvement over the undercutting. This undercutting or under-rolling is to relieve frictional stresses that set up corrosion and reduce the endurance limit values to so low a point as to result in less than 25 per cent service from the pin.

This is a pretty strong statement to make and requires an explanation. When we prepare a crank pin for the wheel fit, it is turned, perhaps ground, and is pressed into the wheel center. When the locomotive goes into service the pin is subjected to reverse stresses, and if there is a tool mark, these stresses instead of being spread over a large surface concentrated in the bottom of the tool mark and shortly a fatigue crack starts. Or if the finish is free from tool marks or other defects, there is a working of the surface of the wheel fit under pressure, and frictional corrosion takes place; stress-corrosion cracks may start, which develop into fatigue cracks and result in eventual failure. By undercutting small widths of the crank pin fit or under-rolling similar distances, we have a surface with only one type of stress and not two stresses compounded, as is the case with the straight crank pin fit. The surface of the pin which is not undercut is subjected to compression stresses, but not to tensile stresses; the undercut portion on the other hand is subjected to tensile stresses, but not to compression stresses. We have thus reduced the range of the stress on the crank pin surface and have eliminated frictional corrosion where there were tensile stresses. If the reduced section made by the undercutting is free from tool marks and is polished, the possibility of fatigue cracks starting will be eliminated.

The failure illustrated in Figs. 1 and 2 is typical of hundreds of similar failures and the savings which could be effected by greater care in machining are enormous.

Fig. 1—Fractured end of crank pin. Upper one-third is of fine texture, somewhat polished, and represents the extent of fatigue crack. This crack developed from the series of small cracks at the top. Fig. 2—Micro-photograph showing finish of wheel fit of crank pin illustrated in Fig. 1. The line of fracture is at the right. Note the roughness of machine finish. Fig. 3—Fatigue cracks started in three places. Apparently the primary one was at the bottom, the secondary one at the top, and the third one at the side to the right. Complications are indicated by the progress of the break between the third fatigue crack and the center of the pin. The fatigue cracks extended through the greater part of the area before the final break. Fig. 4—Micro-photograph showing the rough machined surface of the wheel fit of the crank pin shown in Fig. 3. Fig. 5—Break caused by rough finished fillet adjacent to the wheel fit. Fig. 6—Micro-photograph showing rough machine tool finish in the fillet of the crank pin shown in Fig. 5.

When I started the campaign against rough machine work in our shops I was asked, "What do you want—a microscopic finish?" Conditions have improved and yet we must constantly strive for better finish, and still better finish, and then some plan to protect the better finish. Undercutting or under-rolling should accomplish this. Complete, perfect finish or rolling will not entirely accomplish the purpose, because of corrosion (either wet or dry corrosion); undercutting or under-rolling will afford additional protection.

Another interesting fracture is shown in Fig. 3. This crank pin was applied October 25, 1932, and failed May 29, 1936, less than four years later. Here we have an interesting series of fatigue cracks, all starting from tool marks, the roughness of which is shown in Fig. 4. This is not an unusual case and yet men will be found condoning, defending and ignoring such workmanship in all walks of mechanical life. I have even had a watch repaired that showed file marks comparatively as bad as the tool marks illustrated in Fig. 4, and yet the watchmaker wondered why the watch did not keep good time.

The fatigue cracks started in several places in the fracture shown in Fig. 3, and apparently the section was cracked to about 90 per cent of its area before the pin finally failed. This indicates that the steel was excellent and that the rough machining was undoubtedly the sole cause of the failure. On the other hand, it must be understood that we have no actual means of determining how much corrosion enters into the cause of such a failure, since the rough grooves on the surface of the wheel fit of the pin were no doubt affected by corrosion. Still they are too deep to charge the failure to other than the machining, even though corrosion was a factor.

Second Type of Failures

There is another type of failure which is quite common with crank pins. These occur because of the rough finished fillets adjacent to the wheel fit. A large reduction in the number of such failures has been made by improving the finish of these fillets. An illustration of such a failure is shown in Figs. 5 and 6. A study of Fig. 5, the fractured end of the pin, indicates that there are several separate fatigue cracks, which finally converge and cause failure. As a matter of fact, the pin stood up until well over 90 per cent of the section was cracked through before the final failure took place. All of the fatigue cracks started from the fillet. The enlargement of this fillet in Fig. 6 shows the tool marks and the torn surface of the metal, which obviously was not suitable for resistance to failure from fatigue. Incidentally, while a rough finish of this sort is sometimes found on fillets of new pins, it is usually the result of work which is done when the pin is returned to the shops, because of scoring or for other reasons. Under such conditions it may be difficult to finish the pin properly. This, however, is poor economy, since the pin is quite likely to fail in service.

A solid pin which failed in service is shown in Figs. 7 and 8. Apparently the material was not quite as good as that shown in previous illustrations, since the pin failed when only a little over two-thirds of the section had cracked. The poor machine finish, however, which is illustrated in Fig. 8, was probably mainly responsible for the failure. It will be noted that in Fig. 7 there is considerable frilling near the start of the fatigue crack. This is due to the torn surface which interrupted the progress of the fatigue crack and started it off in different planes as it progressed.

The machine tool, in this instance, was not cutting properly and no doubt was set at the wrong angle and ground with the improper rakes. It is essential, if a

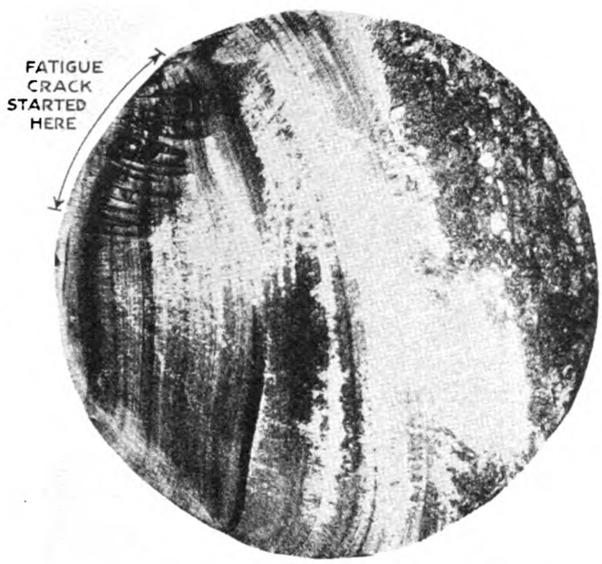


FIG.7

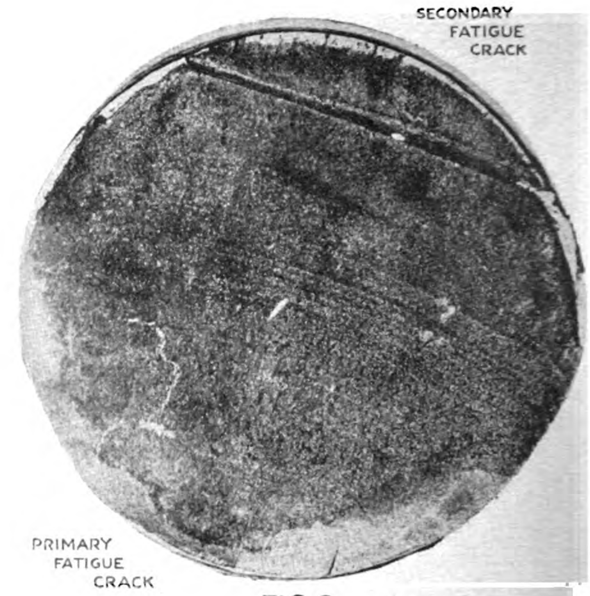


FIG.9

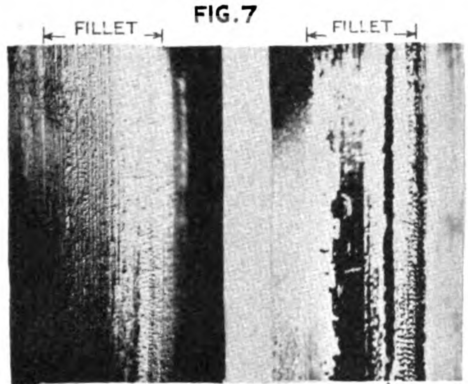


FIG.8

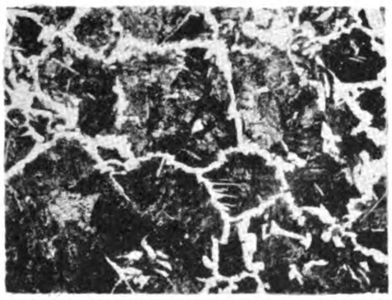


FIG.10

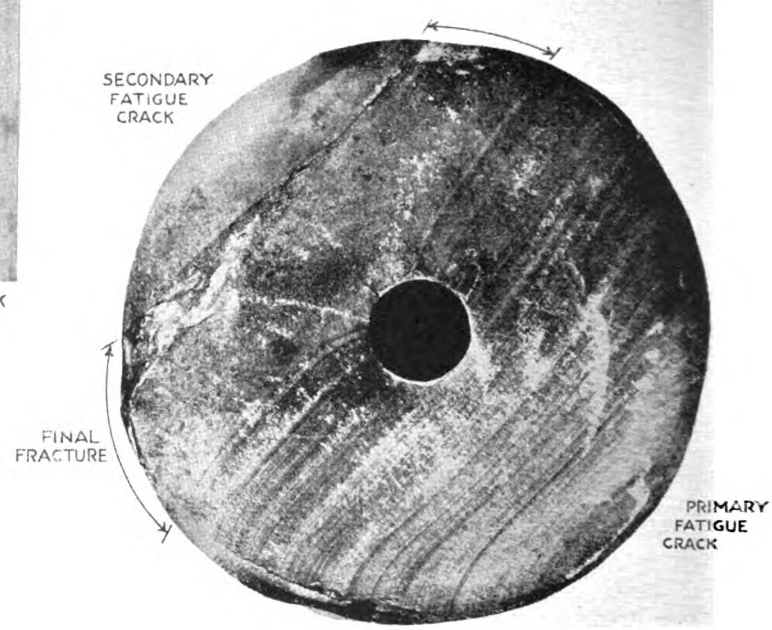


FIG.11

Fig. 7—Broken surface of a solid crank pin. The material was apparently somewhat inferior, but poor machine finish, as shown in Fig. 8, was probably the primary cause of failure. Fig. 8—Micro-photograph showing crack and rough machining in the fillet of the crank pin, the broken surface of which is shown in Fig. 7. Fig. 9—Surface of break in this crank pin indicates rapid progress of fatigue crack. Fig. 10—Microscopic view showing coarse structure of material in crank pin, the break in which was illustrated in Fig. 9. Fig. 11—Another crank pin which failed because of roughness in the fillet

proper finish is to be obtained, that the rakes of the tool be accurately set for the material being machined.

The appearance of the break of the crank pin illustrated in Fig. 9, indicates that the progress of the fatigue crack was rapid. An examination of the structure of the steel under the microscope (Fig. 10) showed that it was very coarse, or was not properly annealed after forging. The structure of the steel was undoubtedly one cause for the very short life of the pin after the crack started, but the initial cause of the fatigue crack was the rough machining. This crank pin was placed in service November 29, 1925, and failed October 30, 1934, after nearly ten years of service, and therefore gave reasonably good service in spite of the poor heat treatment of the steel. It would undoubtedly have given its full life, that is, until worn to the limit, had it been finished properly in the fillet when it was re-turned during shop repairs. It is quite evident that it did not last long after the final turning, because of the coarse grain of the break, which indicated that the fatigue crack spread rapidly.

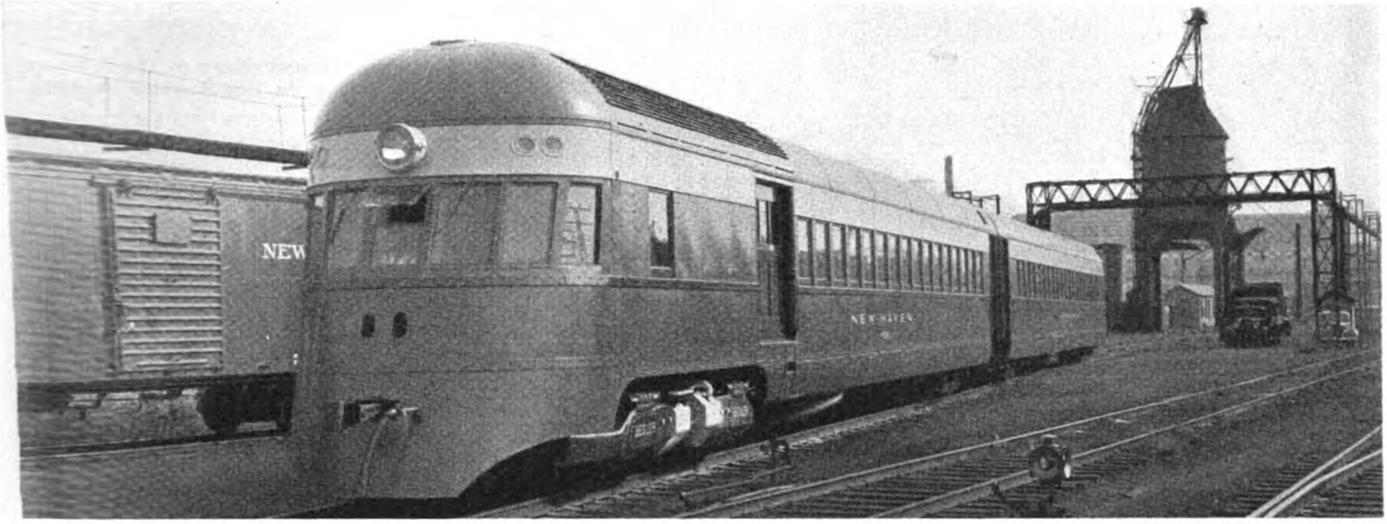
We have in this case, therefore, a pin of poor steel, which lasted for nearly ten years, finally failing because some shopman was either rushed to get the pin turned, or was careless, or because the shop in which it was finished did not consider polished fillets necessary.

The structure of the fracture of the crank pin illustrated in Fig. 11 indicates that it was properly heat treated, and also—because the fatigue cracks extended

(*Continued on page 495*)

Condensing Engines and Automatic Boiler Feature

New Haven Steam Rail Train*



The Besler two-car steam train on the New Haven

THE New York, New Haven & Hartford now has in service, between Bridgeport, Conn., and Hartford, a two-car steam-powered rail train equipped with the Besler steam power plant. This train is operated in almost continuous service from 6:00 a.m. to 10:20 p.m. making six trips of 31.9 miles between Bridgeport and Waterbury and one round trip of 125.86 miles between Bridgeport and Hartford each day, giving a total daily mileage of 317.26.

When it was first decided by the New Haven to use a Besler power plant the idea was to make the most economical possible application, from the standpoint of initial investment, in order to be able to demonstrate in service the capabilities and reliability of the equipment. This would involve simply the application, to two existing coaches, of the power truck, boiler, condensers and control equipment, together with the operating compartments at the ends of the train. A preliminary consideration of this idea, however, indicated that a much better job could be done by a complete rebuilding and remodeling of the two coaches at a comparatively small increase in cost.

As finally completed, loaded with fuel and water ready to run, the weight of the train is 303,600 lb. The two steel coaches which were converted into this train had a weight of 258,400 lb. The application of the Besler power plant and the modernizing of the two cars, plus fuel and water and air conditioning equipment, therefore has only added 45,200 lb. to the weight of the original equipment. With 500 hp. available at the rail the Besler train, ready to run, has a horsepower-weight ratio of 607 lb. (3.3 hp. per ton). By comparison the New Haven Comet, loaded with fuel and water ready to run, weighs 260,590 lb. This is powered with two 400-hp. Diesel engines, giving a total of 800 hp. If, however, all

Two existing coaches remodeled and equipped with Besler power plant providing a flexible facility for use in local service

auxiliary equipment is in operation at once, considering the efficiency of the electric drive, a maximum of 600 hp. is available at the rail. This gives a horsepower-weight ratio of 434 lb. (4.6 hp. per ton). If, instead of applying the Besler power plant in the older steel coaches as was done in this case, such a power plant were applied

Characteristics of Besler Train and The Comet

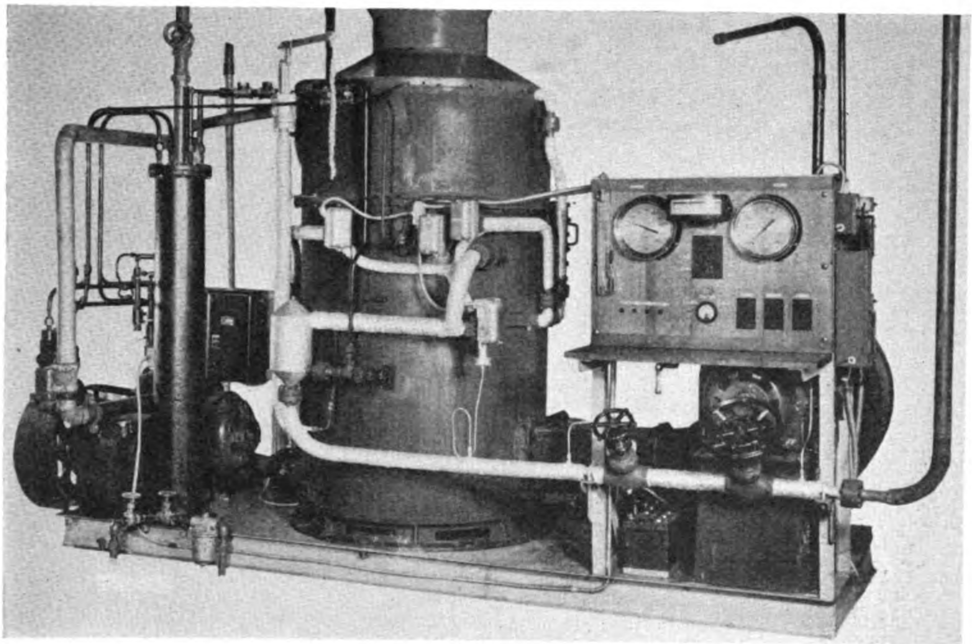
	Besler train	The Comet
Total horsepower	600	800
Horsepower at rail	550	590 (min.)
Seating capacity	152	160
Baggage capacity	12 ft.—3,000 lb.	None
Overall length, ft. and in.	163—2½	207—0
Total weight, ready to run, lb.	306,600	260,590
Distributed weight, power truck, lb.	104,000	86,835
Trailer truck power car, lb.	67,000	43,890
Trailer, inside truck, lb.	65,000	44,375
Trailer, leading truck, lb.	67,600	85,490
Weight light train, lb.	296,100	248,590
Weight power plant and control, lb.	32,700 (approx.)	71,039

to two of the modern New Haven light-weight streamline coaches, it is reasonable to expect that a two car train could be built with a total weight, ready to run, of approximately 250,000 lb. This would have a horsepower weight-ratio of 500 lb. (4 hp. per ton).

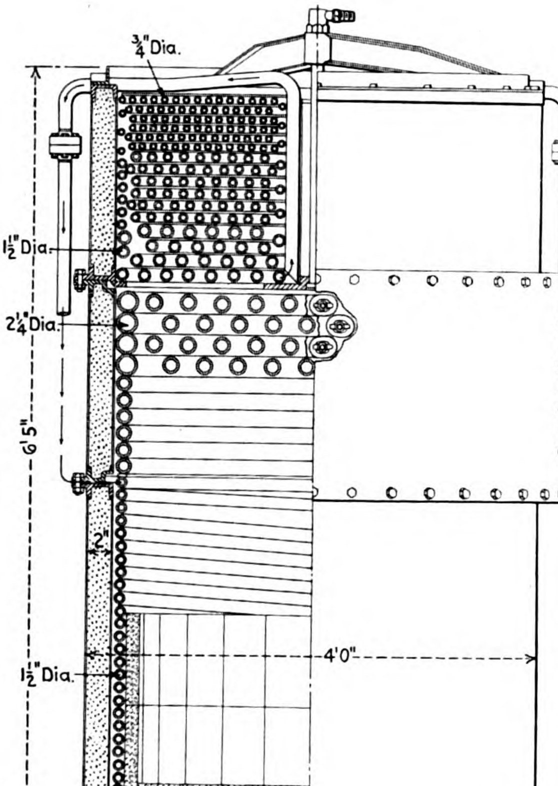
General Construction and Arrangement

Two old New Haven steel coaches, approximately 20 years old, were selected and designs worked out for remodeling them by the application of the Besler power plant and other modifications into a modern appearing streamline train. These old cars were of the monitor-room construction, with narrow letter boards. As remodeled the exterior was changed to give an outside

* This article is based on papers presented before the New York Railroad Club, October 16, 1936, by K. Cartwright, N. Y. N. H. & H. (describing the train), and Geo. D. and Wm. J. Besler (describing the power plant), supplemented by additional details concerning the boiler. There is also included a summary of questions raised during the discussion following the presentation of the two papers.



Steam generator as set up in the laboratory for testing



Half section of the Besler Uniflow boiler

appearance somewhat comparable to the road's latest streamline coaches. The cars were stripped down, lower-deck roof sheets and some details of the old deck framing removed to save weight, and new carlines and roof sheets applied from side plate to upper deck sheets to form a turtleback roof. The old narrow letter boards were replaced with wide letter boards and skirting applied below the side sill and joining in with the side sheathing. All new sashes were applied, the sashes being sealed into the car.

The interior arrangement and appearance of the car were completely changed. In the old cars saloons were placed one at each end of the car. In the new design both saloons were placed at the same end, and they were equipped with toilet and lavatory facilities, including shelves and mirrors similar to the streamline coaches. Mirrors were also applied at each end of the car. The old heavy Tucolith flooring was removed and a light-weight Tucolith floor applied over new chanarch, with an upper floor of composition rubber in a mottled gray pattern, harmonizing with the interior color scheme. This was laid in three strips running lengthwise of the car. The old seats were replaced by new walkover seats especially designed for the cars, having chromium-plated tubular frames with cushions upholstered in a blue figured plush.

The interior cross-section was radically changed, the old clerestory being supplanted by a flat headlining running across the car just below the old lower-deck carlines. Suitable framing was applied across and below the lower-deck carlines to support the new headlining. The space thus made available between the headlining and the roof in the old clerestory section was utilized for the distributing air duct for air-conditioning system. The old lamp fixtures were all removed from the deck and the center of the car and new ceiling fixtures with prismatic lenses set flush with the headlining were applied over each seat. Modern aluminum basket racks were applied in place of the old bronze racks.

The old heating system was completely removed and replaced by fin-tube radiation, thermostatically controlled and interlocked with the air-conditioning system. A center-duct air distribution was used with an electro-mechanical cooling system, operated at 110 volts and driven from a separate 25-kw. generator and auxiliary engine located in one corner of the baggage room. The capacity of the air-conditioning unit in the power car is five tons and in the trailer car seven tons.

On the power car a section 8 ft. long at one end was reserved for application of the Besler boiler plant and auxiliary equipment. Following this is a 12-ft. baggage compartment. The necessary baggage-room door openings were provided in the sides of the car, sufficient reinforcement being applied to compensate for the omission of the side posts made necessary by the wide baggage-room door. The windows in this section of the car were all removed and new sheathing applied over the window openings. The entire length of 20 ft. over

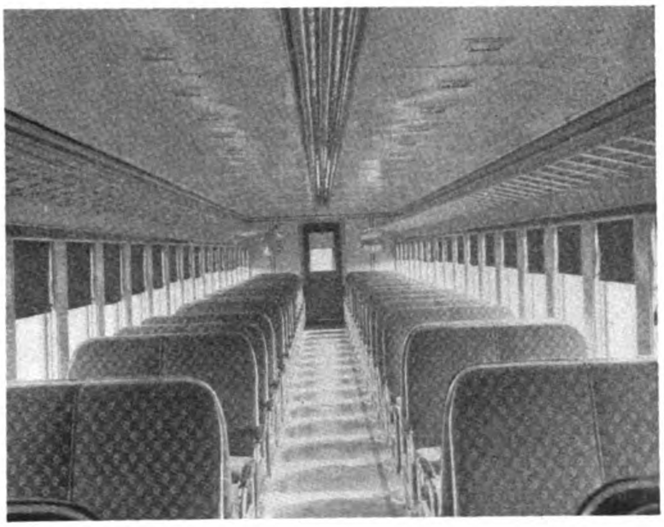
the boiler room and baggage-room on the roof is taken up by the condensers and exhaust-steam-driven fans. A number of special details of construction had to be worked out properly to carry the weight of condensers and fans and also mantain the necessary strength across the sides of the car.

One of the most difficult problems was in the streamlining of the ends. The operator's compartment had to be placed in the streamline end and a sufficient amount of strength had to be worked into an end design that could be readily incorporated into the existing structure. The vestibules were entirely removed with the exception of the existing vestibule end sills. Pressings were applied to the vestibule end sills in order to carry the section forward at that point, and a continuous angle formed at this section, tying into the side sill of the old structure. Other continuous formed angles were applied, tying into the old structure at the top and bottom of the letter board.

The bottom contour of the streamline end was formed by a continuous angle tying into the side-sill construction back of the body corner post. Vertical channel sections were applied, running from the bottom to the top between the window openings in the operator's compartment. A continuous formed outer belt rail was applied, tying in with the existing belt rail back of the body corner post. In this manner a very substantial and adequately protected operator's compartment was obtained. The necessary control apparatus was applied in each compartment and the train is operated in either direction without turning.

Trucks and Brake Equipment

The old truck under the boiler end of the power car was replaced by the Besler power truck, all other trucks remaining the same. The old PC brake was removed and replaced by HSC equipment, and two brake cylinders, 10 in. by 10 in., were used on the power truck, the old 16-in. by 12-in. cylinder on the original car being retained for braking the rear truck on the power car. One 16-in. by 12-in. cylinder is used for braking the trailer car. The old axle generators and batteries were removed from both cars, a new battery being applied to the trailer car of only sufficient capacity to provide starting for the Besler equipment. The lights are operated from the 5-kw. auxiliary generator in the boiler room, this generator being in continuous operation whenever the train is in service.



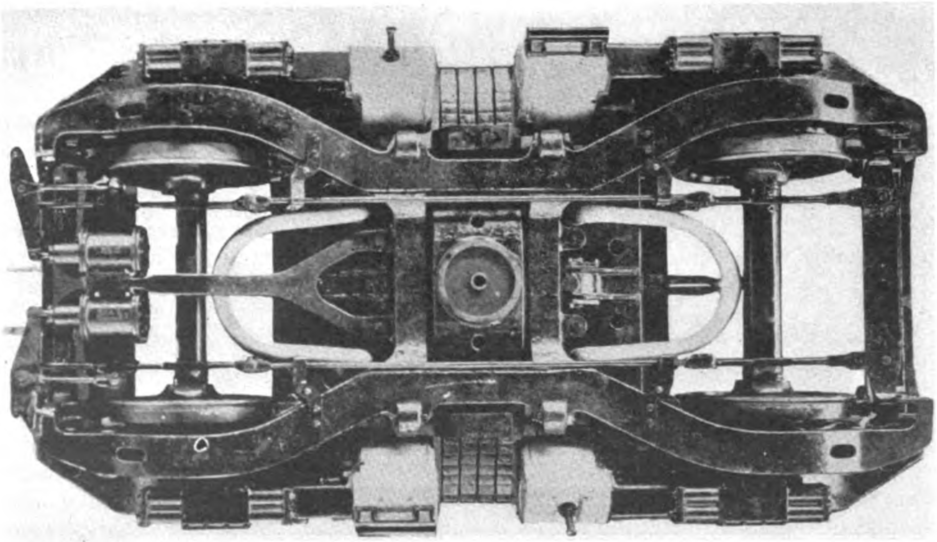
The interior of one of the coaches

Fuel and water tanks of 500 gallons capacity each were applied to the power car. The cars were semi-permanently connected together, the old couplers and draft gears being retained. The free travel in the draft gears was taken up and some initial compression placed in both gears so that no slack action would be experienced. The uncoupling levers were removed, necessary wiring and control connections were made between the cars by jumpers which can be removed if it should ever be necessary to cut the cars apart.

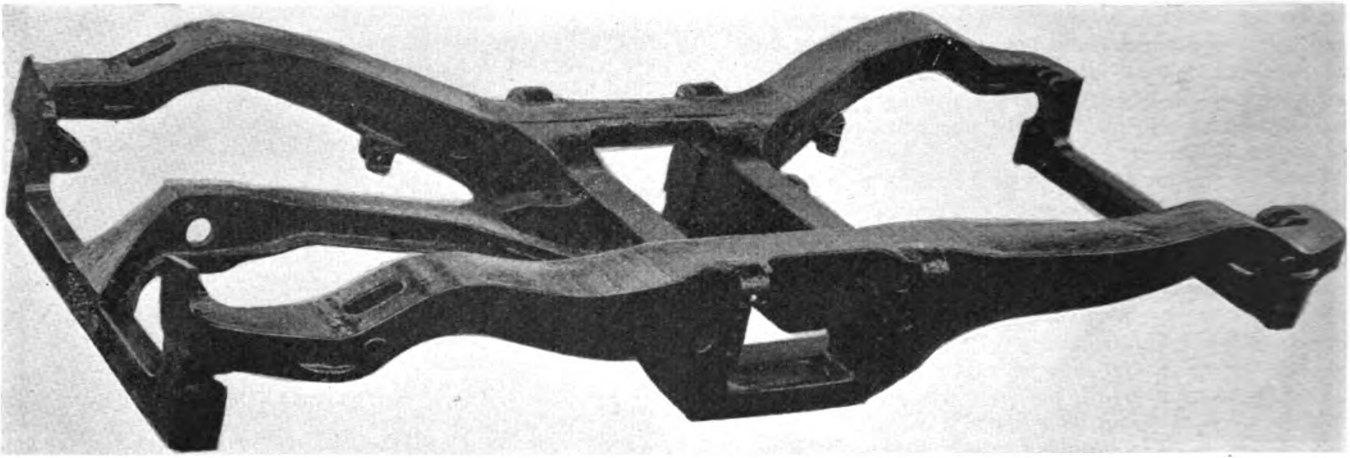
The interior of the cars was finished with the same color scheme as the road's streamline coaches, the headlining being a light cream down to the frieze board; frieze board, window panels and ends of car down to window capping, aluminum, and sides and ends below the window capping, a dark gray. A red stripe was carried around the car at the molding above and below the baggage rack. The exteriors were painted a royal blue up to the letter board, with a stripe of pimpernel scarlet the full width of the belt rail. The letter board was finished in aluminum and the roof a darker shade of blue.

The Power Truck and Engines

The overall length of the power truck is 17 ft. 8 in., and the total width over the cylinder lagging cover is



Top view of the power truck showing the truck and engine-frame castings, and the brake and spring arrangement



The cast-steel power-truck frame

9 ft. 5 in. The wheelbase is 11 ft. 6 in., and Bethlehem low-carbon molybdenum wheels with chrome vanadium axles are used. Four coil springs at the extremities support the over-riding truck frame which in turn supports the car body through a conventional swing bolster and elliptical spring plank.

Simplex clasp brakes are used, with two brake cylinders mounted on the truck. Westinghouse slack adjusters are provided, and there are two brake shoes on each wheel.

The over-riding truck frame is a large four-legged spider, and two engine yoke frames, which ride with and take their alinement from the axles, are attached to the truck frame by ball joints.

The total weight of the power truck is 35,000 lb.

There are two direct, two-cylinder compound engines, each having cranks pressed onto extensions of the axle stub outside of the journal bearings. The high-pressure cylinder is 6½ in. in diameter and the low-pressure cylinder is 11 in. in diameter. Both cylinders have 9 in. stroke. These are conventional double-acting compound engines, with piston valves. The crossheads are cylindrical in shape and are made of cast steel with babbitted shoes. All bearings are of the roller type throughout and all working parts are machined all over.

The valve mechanism is a Stephenson link motion arranged to be operated pneumatically to give two positions forward and two positions reversed. All piston and valve rods are of Nitralloy and the wrist pins are of the full floating type, made of Nitralloy running in phosphor-bronze bushings. The lubrication is accomplished by splash within a sealed crankcase, and a circulating plunger pump is furnished to assure lubrication at slow speeds. The cylinder relief valves are air operated.

The engine is designed for a steam pressure of 1,500 lb. per sq. in. and, at 1,200 lb. inlet pressure, the truck has an average starting tractive force of 15,000 lb. The truck is rated at 1,000 hp., although it is capable of producing more than this with sufficient boiler capacity.

The Boiler

The boiler is of the continuous-flow, non-water level type, having no drums or headers. The general arrangement of the coils in the boiler is shown in an accompanying drawing. The tubes in the coils vary in diameter from ¾ in. in the top rows to 2¼ in. diameter in the superheater section. The water enters the top of the boiler, passing down through the pancake coils where it is heated in the coils in the top six coil sections. In the next lower six coil sections the water is gradually changed to steam. Having reached a point in the boiler directly above the superheater coils, the saturated steam passes through a tube, indicated by the arrows in the drawing, to the outside of the boiler through which it is taken to the top of the coil group which entirely surrounds the side walls and bottom of the combustion chamber. The steam in working its way through these coils passes down alternate rows to the bottom coil underneath the combustion chamber. Having completed a circuit in the bottom coil, it passes up other alternate rows of tubes to a point at the top of the combustion chamber where it enters the bottom of a seven-tube coil immediately under the superheater section. After passing through this section it goes into the superheater section composed of five rows of header type coils. The superheater coils are U-shaped in arrangement with the return bends at one end and a cross-header between coil units at the opposite end at which clean-out hand-hole plates are fitted to the boiler shell. The formation of scale in this type boiler is confined to the superheater section and the clean-out hand-holes are provided to facilitate the use of a mechanical cleaner in the superheater tubes. The entire boiler is encased in an airtight sheet-steel housing with 2 in. of insulation between the inner and outer casings. The inner casing is constructed of corrosion-resisting Inconel and the outer casing, separated from the inner casing by insulating brick, is made of sheet iron.

The boiler is equipped with fully automatic safety devices to protect it against empty water tanks or other contingencies.

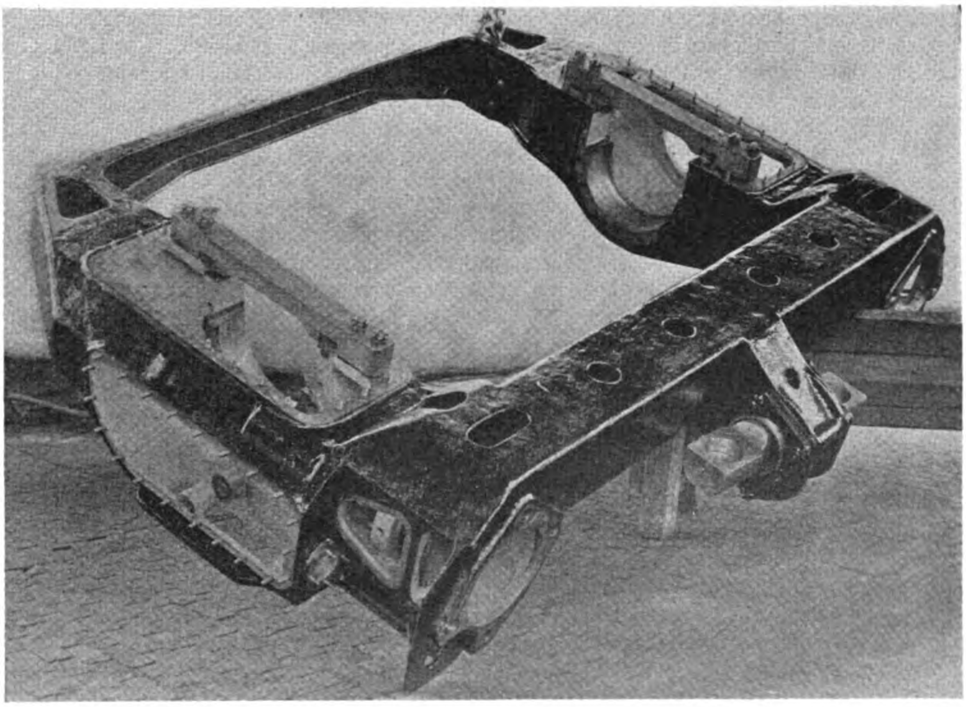
The Oil Burner

The burner is the pressure atomizing type of Besler design and construction. It automatically meters the fuel in proportion to the flow of air which is delivered by a multivane type blower. Adjustment is not necessary because of a change of altitude or a change in draft pressure, and the burner automatically compensates for changes in air flow caused by entering tunnels, high speeds, or cross winds—in every case metering the correct amount of fuel. The burner operates fully on or off. Ignition is secured by a high-tension electric spark.

Auxiliary Engine

The auxiliaries are driven by a two-cylinder, 90-deg. V-type double-acting steam engine. The water pump drives are integral wtih the main crank shaft. The auxiliary steam engine drives the electric generator through V-belts. The generator supplies current for lighting, ventilating and for the requirements of the power plant.

Cast-steel engine frame showing the bolting locations for the cylinders and crank-case cover plate, and the ball-joint connection to the truck frame—Two of these castings are used in each truck



The auxiliary engine also drives the air compressor and the forced-feed main-engine lubricators. It operates at a back pressure and exhausts into the train-heating line. When train-heating is employed the power used to drive the auxiliaries represents only two per cent of the boiler output.

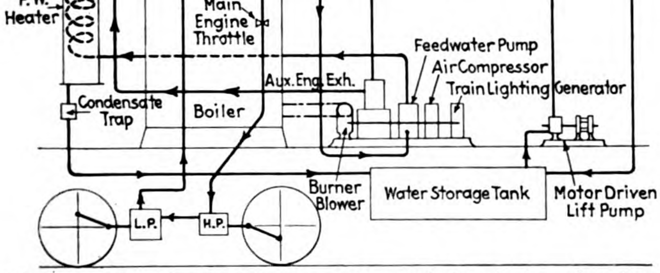
The Condenser

The condensers are of the fin and tube type, placed on the roof of the car. Propeller type fans driven by individual exhaust-steam turbines of our own design and manufacture are located adjacent to the condenser cores on the roof and draw air through the cores, discharging it upward.

The turbine speed inherently varies in proportion to the steam flow, producing the optimum relation between air flow and condenser load at all outputs.

General Scheme of Operation

Reference to the accompanying schematic diagram will help clarify the functioning of the various units involved in the power plant and auxiliary. Water from the main storage tank is pumped by a motor-driven lift pump to a header tank, thence to the boiler feedwater pump which is one of the three auxiliary units driven by a high-pressure auxiliary engine. From the feedwater pump the water passes through the feedwater heater, thence to the boiler. Its course through the boiler has been previously described. Superheated steam at constant temperature and at a maximum pressure of 1,500 lb. per sq, in. leaves the main steam outlet of the boiler. Superheated steam is used in the main engines on the power truck and in the auxiliary engine. The main engine exhaust is piped to the three condenser fan turbines. The auxiliary engine exhaust is piped to the feedwater heater. Exhaust steam after passing through the feedwater heater and the fan turbines goes to the condenser header which is equipped with a safety valve as a protection against excess pressure in the condenser coils. The condensate from the condenser passes through a return line to the water storage tank.



Schematic diagram showing the relation and functioning of various parts of the equipment

Questions and Answers Concerning Operation

At the New York Railroad Club meeting at which the description of this train was presented many questions were asked concerning this equipment. The answers to a number of these questions as given by W. J. Besler, are included herewith.

1. Q.—*What is the percentage of makeup water in the summer time when steam is not used for heating?* A.—It is approximately the same as in the winter when water is lost through heating. In the winter time, there is no return from the heating pipes, so that the water is wasted. No records of the amount of water consumed by the power plant are available at present.

2. Q.—*How is scale formation prevented in the boiler?* A.—Scale is not prevented. Scale forms only in a certain portion of the boiler which is provided with clean-out openings. Cleaning is accomplished either by dissolving it, or by the use of a turbine cleaner after removing the clean-out plugs, which is a simple operation. Any other means of feedwater treatment may be used to keep down the scale deposits.

3. Q.—*Is the steam superheated?* A.—Yes, the

steam is superheated. At 500 lb. pressure or 800 lb. pressure, the temperature is maintained constant at the outlet of the boiler and runs 760 degrees. It is maintained at that point to give a good overall efficiency and good lubrication.

4. Q.—*How does oil treat the feedwater?* A.—Oil goes into the feedwater because the engines are lubricated by spraying oil into the engine cylinders. The oil is carried to the condensers and from there it is returned to the feedwater tank. This oily feedwater is pumped to the boiler, which is one of its features. In a steam automobile boiler, which is now 27 years old, the boiler has never been touched. The tubes are perfectly clean because of the presence of a large percentage of oil. Upon analysis this was found to be some four or five percent of the feed water.

5. Q.—*Is straight mineral oil or compounded oil used?* A.—Both types of oil are used.

6. Q.—*Does the atomizing burner run intermittently or at varying speeds, so as to develop steam in proportion to the speed requirements of the train?* A.—The atomizing burner is of the on-and-off type.

7. Q.—*How is feedwater regulated?* A.—There is a control mechanism which supplies water whenever the pressure is sufficiently low and whenever the temperature is right. The injection of water is proportioned according to the temperature within the boiler. It is fully automatic in operation.

8. Q.—*What kind of fuel is used?* A.—So far, any type of fuel has been used with which we have come in contact. On this train the lighter grade of fuel is preferred, as the cost is not yet prohibitory. Any of the oils produced in America can be burned, as they have been tried in the laboratory.

9. Q.—*What is the combustion rate in the boiler?* A.—Over 500,000 B.t.u.'s per cu. ft. per hr., although a maximum of over 2,000,000 B.t.u.'s per cu. ft. per hr. have been released.

10. Q.—*What is the stack temperature?* A.—500 deg. F.

11. Q.—*What is the water rate of the engine at various speeds?* A.—10 lb. over a wide range of speeds and loads. That water rate can be maintained from 1200 lb. inlet pressure down to 400 lb. inlet pressure, which is the operating range at the present time.

12. Q.—*How frequently must scale be removed from this type of boiler?* A.—The present indications are that it should be removed each 30 days, although on the New Haven train, it was operated the first six weeks without removing scale.

13. Q.—*What is the weight of the boiler?* A.—5,100 lb. complete.

14. Q.—*What effect will snow have on the condenser exhaust fan?* A.—When snow comes in contact with the fans two things may happen to dispose of it. Either the fans will throw it out of the way or the heat will melt it.

15. Q.—*What is the temperature of the boiler room?* A.—Temperatures as high as 140 deg. have been recorded in the boiler room, although at that time no one was in the room.

16. Q.—*Are conventional snap rings used on the pistons of the engines?* A.—Yes.

17. Q.—*How many rings are used on each piston?* A.—Six.

18. Q.—*What is the maximum speed of this train, and at what speed is maximum horsepower developed?* A.—The horsepower is constant from 12½ to approximately 65 miles per hour. The train is guaranteed to do 70 miles per hour, although on one run a maximum of 82 miles per hour was reached. Operating conditions necessitated limiting the speed, so that it is not possible to say how much more speed it might be possible to attain.

19. Q.—*Is a fireman used on this train?* A.—Yes, when the train is backing up, that is, being operated by means of the controls at the opposite end from the power unit, the fireman rides with the engineman, 160 ft. away from the boiler.

20. Q.—*How much power is required for the condenser exhaust fans?* A.—The condenser fans require approximately 30 hp. under a full load. That is available at a loss to the engine which is not very great, as 12 lb. back pressure on the engines does not amount to much horsepower. Turbines are used for driving the fans.

21. Q.—*With moderate volume production, what proportion of the total cost of the train is in the power plant?* A.—On the New Haven train, approximately one-fourth of the cost is represented by the power plant and three-fourths for the train.

22. Q.—*Approximately how long would it take to remove the power truck and install a reserve truck in case of necessity?* A.—If a reserve power truck were available, it would merely be a problem of lifting the car, rolling the new truck in, dropping the car and making the various steam and air connections.

23. Q.—*Is the boiler operated at constant pressure?* A.—No attempt is made to maintain constant pressure. The boiler operates at a constant superheating outlet temperature. A constant temperature is maintained, as that is what determines proper lubrication and efficiency.

24. Q.—*Is the lubricating oil atomized into the cylinders or fed onto the cylinder walls?* A.—It is fed into the valve chamber and atomized by the velocity of the steam.

25. Q.—*What is the fuel consumption per hour?* A.—One lb. of fuel per hp. hr.

26. Q.—*When the train is operated by means of the controls at the opposite end from the power unit, what controls and what gages does the operator have for feedwater for the boiler?* A.—The controls consist of a throttle, air-brake valve and reverse mechanism. There is nothing to indicate to the operator what is going on at the power plant, as the operation of the boiler is entirely automatic.

27. Q.—*What type of a transmission is used?* A.—There is no transmission. The steam engine connecting rods are directly connected to cranks which are pressed on to an extension of the axles. It is interesting to note that there is not a single gear of any description on these two cars.

28. Q.—*How is the control operated from the opposite end of the train?* A.—Pneumatically.

29. Q.—*What is the storage capacity of the boiler?* A.—Only enough to go about half a mile. Storage capacity is not carried in the boiler water, but in the hot tubes. As the pressure drops an additional quantity of water comes from the economizer section of the boiler, and in contacting the hot tubing it generates steam which gives this boiler its amazing reserve capacity.

30. Q.—*How long does it take to get the boiler hot from cold water?* A.—The rail car is able to get steam up in an average time of five minutes from dead cold. It cannot be operated in five minutes, however, because of the necessity of pumping up air for about 12 minutes. The time required from stone cold to the point where it is ready for operation depends upon the time required to pump up air. As far as the boiler is concerned, working steam pressure can be built up in approximately 3¼ to 4 min. from the time the fire is started.

Causes of Failures of

RAILROAD SPRINGS

By R. W. Clyne*

THE replacement cost of a broken spring is not the only economic factor resultant from the fracture; in fact, the principal loss in dollars may generally be attributed to the service loss of the equipment during the repair period. The value of the spring itself is also generally small when compared to the interchange charge or the labor and overhead costs arising in the yard during the servicing of a car or locomotive. These various charges, direct and indirect, arise of course, from the original spring failure and may frequently be eliminated by a more comprehensive understanding of the fundamental causes of failure. Spring manufacturers as well as railroad engineers must become aware of the factors influencing the service behavior of springs, for the problem of reduction in the charges resulting from failure is a mutual one.

Solution of the problem is largely technical and involves the practical application of the latest advances in metallurgy, physical testing and design, as well as appreciation of the fact that *the cheapest spring* is usually the *most expensive one.*

In view of the fact that maximum stresses in railroad helical carbon steel springs are frequently as high as 150,00 lb. per sq. in. and that maximum stresses in alloy elliptics of 160,000 lb. per sq. in. are not uncommon, it is not difficult to realize that the potential sources of failure are numerous and may originate in the rolling mill or in the original design, or during manufacture or in service. Due to the singularly high stresses which mechanical springs sustain during service, premature failures may be encountered if metallurgical or physical testing principles are ignored during any process of manufacture or during service. This expectation is not lessened by the present trend towards higher railroad speeds, lower spring weights, alloy steel and high spring stresses.

Overheating of the steel during manufacture is one of the chief causes of reduced resistance of springs to service conditions. Occasionally, overheating takes the form of actual burning of the steel and when this occurs it is usually due to carelessness and poor workmanship during the heating operation prior to tapering. Another form more frequently assumed by overheating is the formation of a maze of surface blisters and general deep surface roughness due to extreme oxidation—usually caused by the employment of very high furnace temperatures prior to coiling, in an effort to coil large bars rapidly. This condition is generally found in bars of 1-⅝ in. diameter steel and larger when a manufacturer does not have a coiling machine of sufficient strength to successfully handle bars of these sizes when heated to the proper temperature. While reheating and quenching of these bars will usually produce the desired micro-structure, the original rough and pitted surface is retained, and as a result the fatigue strength and service life of the finished spring is materially reduced.

Burning and extreme surface roughening are reflections of poor operations control and improper equipment, and should not be encountered in modern spring production. There is a final aspect of overheating, however, the continuation of which is almost entirely due to economic pressure on the part of purchasers, and to which may undoubtedly be ascribed a large proportion of carbon steel spring failures. The quenching of carbon springs direct from the shaping operation (single heat treatment) is generally a practice which should be abandoned, for if the steel is heated to a temperature sufficiently high to compensate for heat losses at the bar ends and plate edges during shaping, the micro-structure has been so coarsened that the finished spring is unfit for severe service and is susceptible to early failure. This excess grain growth and wide variation in hardness and hardness penetration result in lowered impact resistance, lowered fatigue resistance, and wide scatter in resistance of the springs to service conditions. In addition, springs of such coarse micro-structure are probably susceptible to

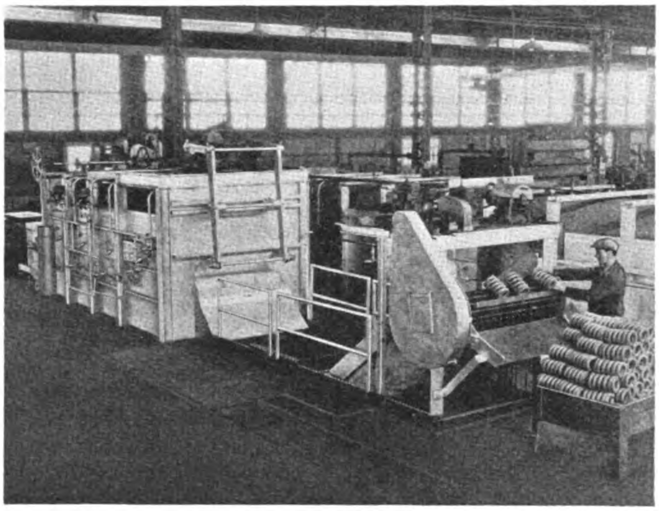


Fig. 1—Pyrometrically-controlled automatic furnace used in heating springs above the upper critical temperature

permanent set in service, for another effect of the overheating and irregular cooling prior to the quench is the building up of severe and highly variable internal stresses upon quenching, which cause marked contraction of the usable elastic range of the steel. Permanent set and permanent injury of the steel may be the result of this action.

Now the cheapest and simplest and most effective means of eliminating the hazards of quenching steel springs direct from the shaping operation is to employ the so-called "double heat treatment" method.

In this process, as practiced by the American Steel Foundries, the coiled springs are air cooled to a black color, are then reheated to slightly above the upper critical temperature, in pyrometrically controlled automatic furnaces of the type shown in Fig. 1, and are then oil quenched. Thus, the temperatures necessary for rapid and precise coiling may be used without adverse effects

* Sales engineer, American Steel Foundries, Chicago.

for the desired micro-structure is formed during the second heating and is retained upon quenching and drawing. This micro-structure is almost completely independent of the temperature of coiling.

The resultant spring is metallurgically correct (through the heating and quenching operations) and this condition is reflected in longer service life and increased resistance to permanent set and repeated loadings.

Upon removal from the quenching medium the springs are exposed to the drawing temperature in order to reduce and equalize internal stresses and hardness and increase the elastic range. Time-temperature relationships are of extreme importance during this operation if equalization is to take place without severe reduction in tensile strength and elastic and fatigue ranges. The advantages of alloy steels are materially curtailed if high tempering temperatures are employed and the steel is so softened that the resultant physical properties are greatly reduced. Short exposure to high temperatures (as in flash drawing) has little effect on internal stresses and produces sharp reduction in tensile and torsional properties of the surface layers. The net effect of this treatment is the establishment of an unbalanced condition throughout the spring. Maximum strength and resistance is applied dynamic loads is a function of both time and temperature during the drawing operation and it is essential that the proper relationships be applied to standard shop practice. The principal drawing furnace used by the American Steel Foundries at their Hammond, Indiana spring works is shown in Fig. 2. This automatic furnace is designed for the treatment of both helical and elliptic springs. It is of the three zone continuous apron conveyor type, gas fired, and temperatures are maintained by potentiometer recording controllers.

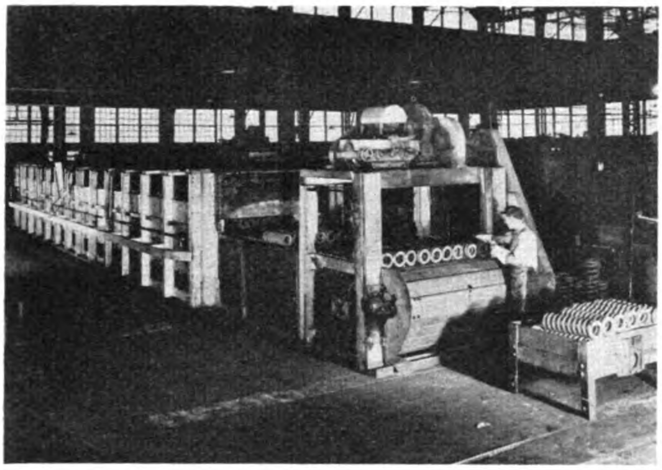


Fig. 2—A.S.F automatic drawing furnace designed for the treatment of both helical and elliptic springs

Stress-corrosion and decarburization are probably the two greatest sources of reduced spring strength and service failure. Our researches indicate an increase in fatigue strength of approximately 65 per cent if the decarburized surface of heat treated elliptic plates is removed by grinding. Apparently, the decarburization effect is greater than any possible effects which may be ascribed to alloys or heat treatment. The combination of effects produced by controlled gas mixture and scaling in a continuous heat treating furnace of the type shown in Fig. 3 is such that free ferrite is practically eliminated. This condition should contribute towards increased service strength by reduction in the zone of weakness. While it is possible to control the carbon-free volume in spring steel, no practical and completely effective solution has yet been proposed to the problem of complete control of all surface layer carbon during the various heating operations to which spring steel is subjected. The solution will require the cooperative research of the steel mills and spring manufacturers. The concession to decarburization is too large to be allowed to continue indefinitely, and extensive and joint research must begin in the very near future. Stress-corrosion occurs in all service in which dynamic stress and corrosion proceed simultaneously. The American Steel Foundries has promoted active research in this field also and has developed an inexpensive protective surfacing which should materially increase the life of railroad helical springs which are exposed to severe corrosion conditions, such as occurs in refrigerator car service. Our researches on stress-corrosion show that 300,000 cycles is the average laboratory life of helical springs when exposed to 3 per cent salt solution and a stress range of zero to 44,000 lb. per sq. in. This early failure is due to the rapid formation of sharp and deep stress corrosion pits and cracks of the type shown at 100 diameters in Fig. 4[1].

In the absence of corrosion, however, and under the same stress range, helical springs failed to break in laboratory tests after 2,000,000 loading cycles, at which time the test was discontinued. While it seems that steps can be taken to check the effects of stress-corrosion on helical springs, there appears to be little that can be done economically to afford similar protection to elliptic springs; however, the situation is not as serious as might be concluded from the laboratory tests, for the service life of the majority of railroad springs is long and satisfactory, despite the continual exposure to corrosion. Apparently, the average service stress range is only a fractional part of 44,000 lb. per sq. in. or some strongly protective oxide coating is formed during service. Nevertheless, it is undoubtedly a fact that, in some types of service many of the spring failures are due to stress corrosion. Where, in this type of service, perishable products are in transit and losses may be sustained during shipment delays due to spring failures, all possible

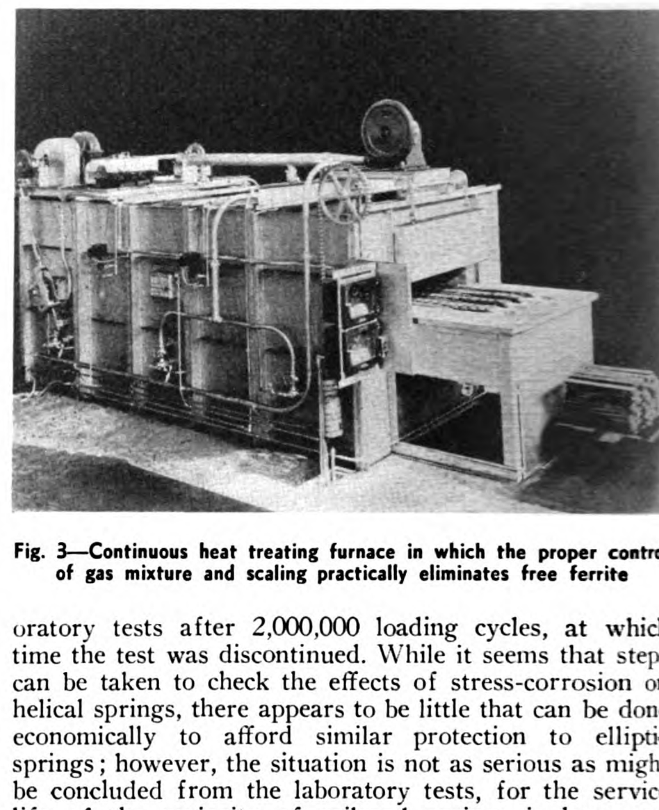


Fig. 3—Continuous heat treating furnace in which the proper control of gas mixture and scaling practically eliminates free ferrite

[1] "Influence of Chemically and Mechanically Formed Notches on Fatigue of Metals" by Dunlap J. McAdam, Jr., and R. W. Clyne, Journal of Research of the National Bureau of Standards. Volume 13, No. 4, October, 1934. This paper considers, among other things: (1) the importance of stress concentration due to notches as the cause of service failures. (2) The effect of chemically formed notches and the relationship between tensile strength and percentage decrease in fatigue limit of steels and aluminum alloys which have been exposed to the influence of pitting caused by stress-less corrosion. (3) The determination of whether composite curves of similar form may be obtained from study of experimental data obtained by a number of investigations of mechanically formed notches. (4) The relationship between notch sensitivity (as measured by percentage damage to fatigue limit) and other properties of metals, such as hysteresis, ductility and work hardening capacity. (5) The influence of notches in diminishing the advantage of superior strength.

steps should be taken to eliminate stress-corrosion. Our tests indicate that the common paints afford no protection, and that metal deposits are expensive and generally inefficient. The problem is entirely different from that of static corrosion.

The effect of surface discontinuities as stress raisers or sources of stress concentration is well known. Spring steel, as received from the mill, should be carefully inspected, principally for rolling grooves, seams and laps for these discontinuities may frequently be the source of fatigue failure in the spring under repeated service loadings. It is generally quite difficult to identify these mill defects in the bars as received due to the presence of the mill scale. It is advisable to inspect pickled coupons of carbon steel. Silico-manganese steel, which is particularly susceptible to the formation of rolling seams, should be purchased in the pickled condition in order to facilitate surface inspection, and absorbed hydrogen may be ignored due to the subsequent heating operations. Occasionally it is necessary to resort to compressive tests of small sections in order to expose incipient surface defects in mill spring steel which is to be used for certain types of service. Magnetic methods of inspection for surface cracks in spring steel are receiving considerable attention at the present time and may become a part of standard shop practice in the near future.

An additional source of spring failure is frequently found in design. The design may be incorrect with respect to the spring itself or to the space allotted to the spring in the structure of the car or locomotive, or the design may be at fault because it calls for the wrong type of spring for the service to be encountered.

In the case of coil springs, design failures may frequently be traced to misunderstanding or ignorance of

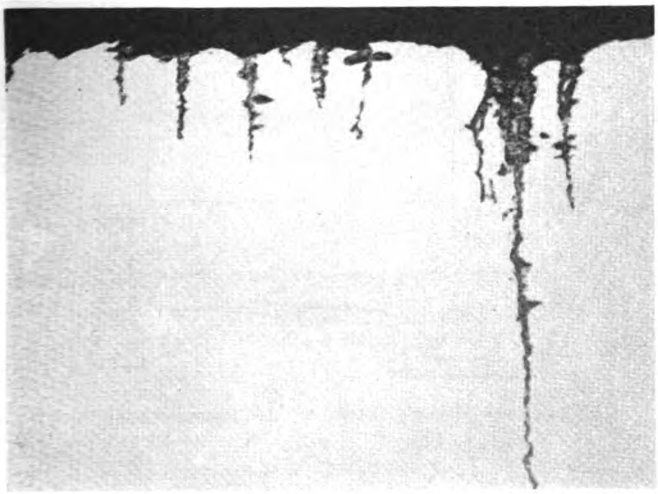


Fig. 4—Deep stress corrosion pits and cracks magnified to 100 diameters

the effect of bar curvature in sharply coiled springs. For example, a coil spring with a ratio of mean coil diameter to bar diameter of four may be designed with an apparently safe nominal maximum stress of 90,000 lb. per sq. in.; actually, however, this nominal stress is increased 40 per cent due to the effect of sharp curvature and this stress condition may produce early failure in some types of service. Recognition of the effect of curvature and application of the principles established by Wahl, Adams and Roever to routine helical spring design will, of course, eliminate this possible source of failure.

Structural failures have been traced, in some cases, to spring designs which allowed for frequent and complete closure with resultant adverse impact loadings. Springs which work under these conditions rapidly acquire permanent set and the repeated stressing in the plastic range materially reduces the fatigue resistance of the steel. The probable effect of the repeated overstress is the formation of incipient surface cracks. Subsequent heat treatment will not remedy this condition. Accordingly, the reworking of springs which have acquired severe permanent set in service is a practice of doubtful economy.

Eccentricity in loading, caused by the bearing coils in helical springs, increases nominal stresses. The stress increase is subject to analysis and the proper factors have been incorporated in the American Steel Foundries' design tables, as have the factors for the effect of bar curvature. The stress factor due to eccentricity varies with the ratio of solid height to bear diameter and the stress increase is greatest in short springs and should be given particular attention in the design of such springs. Elliptic spring fractures which may be traced to the original design are usually found to be due to a stress condition which is frequently the result of failure to consider the effect of sectional concavity or of plate ends or of plate offset or of too many full length plates. The effect of friction in increasing stress has generally been ignored. Static friction and its effect upon the transmission of forces must be considered in spring riggings as well as flexibility of the springs at the ends of the rigging. Occasionally, elliptic plate failures arising from the "shop" design are due to too little "tuck"[2] in the back plate, causing high mean stresses under the service range, or too much "tuck" in the short plates, causing the same adverse condition in these members.

Now the precautions adopted by the American Steel Foundries to insure reduction in the possible sources of railroad spring failures are numerous and very effective. These precautions are almost entirely based on extensive research and have taken the very practical forms of: Continuous heat treating furnaces, automatic coiling equipment, direct reading Brinell hardness testing machines, heat exchangers for automatic temperature control of quenching oil, high speed large specimen fatigue machinery, investigation of decarburization and stress-corrosion, specialized inspection methods for rolling mill defects, and the development of spring tables and working diagrams which consider the effects on stress of curvature, loading eccentricity, dead coils, friction, plate ends, plate offset, etc.

Disc-Flo Journal Bearing Unit for High-Speed Service

A new type of journal-bearing unit, known as the "Disc-Flo," has been developed by the research laboratories of the National Bearing Metals Corporation, St. Louis, Mo. This unit, free-oil lubricated without waste packing, is designed to operate with safety and economy in high-speed passenger service under all weather conditions, having been tested in the laboratory at continuous speeds up to 200 m.p.h. with full load and temperatures as low as 40 deg. F. below zero.

Two cars equipped with Disc-Flo units, placed in regular revenue service the middle of last June, have each made about 25,000 miles, it is said, with very satisfactory results. One of the illustrations shows a six-wheel car truck, equipped with Disc-Flo units, and another illustration gives a side view.

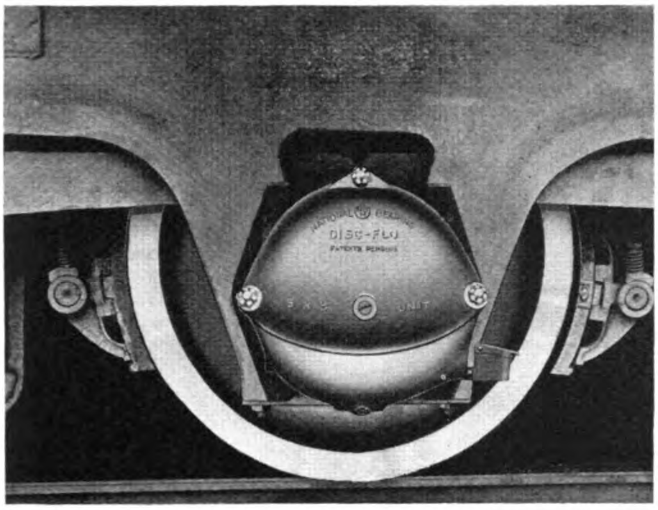
. The principal design features of the Disc-Flo unit,

[2] Tuck may be described as the space existing between the plates of an elliptic spring at their center when the spring is assembled, but not banded, and this space is due to intentional differences in camber or radius of curvature of individual plates comprising the spring.

as shown in the cross-section drawing, are as follows:

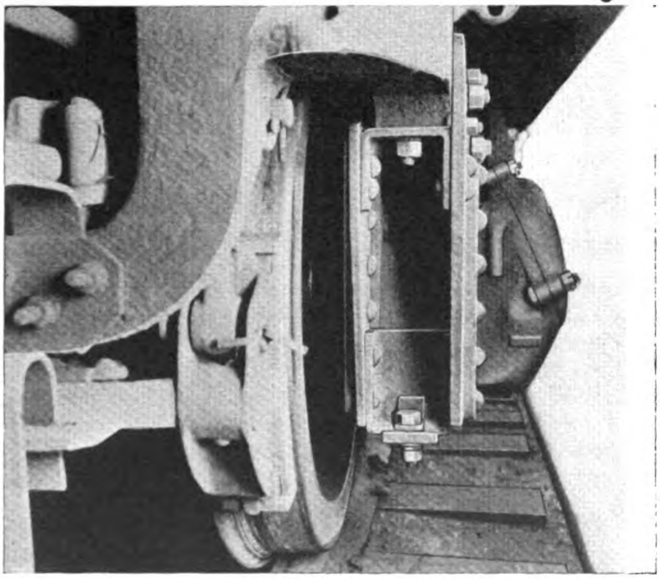
The journal box is made of cast steel. A manganese-steel insert in the top of the box provides a long-life bearing surface for the equalizer and a ground concave fit for the self-aligning steel wedge.

The journal bearing is made of bronze with babbitt lining. It is provided with a flat back to eliminate any tilting which might be caused by coupling shock, starting or braking forces. The bearing has 180 deg. arc of journal coverage, which increases the thrust capacity 50 per cent. The system of oil circulation in the bearing is so shaped that it forms a wedge between the bearing lining and the journal, permitting a ready flow of lubrication under the crown of the bearing with rotation in either direction. A reservoir is also provided to collect any foreign matter in the circulating oil, keeping it from getting in between the surface of the bearing and the journal.



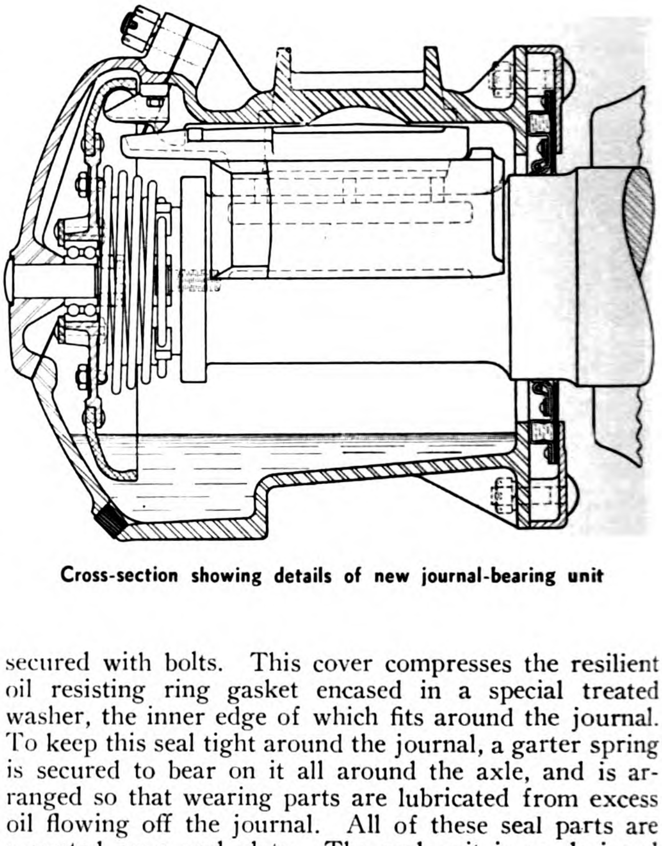
The Disc-Flo journal box

The lubricant is supplied to the bearing by means of a disc which rotates on a roller bearing attached to the inside of the journal-box cover. This picks up the oil and conveys it to the top of the box, where it is wiped off by a metal spoon; the oil then flows through the wedge and bearing to the journal. Oil in excess of that required for bearing lubrication overflows the wedge over the outside of the bearing back to the bottom of the box. The disc is propelled by a nest of two steel torsion springs of opposite pitch, firmly anchored in the disc and both attached to a male cross bar on the free end, which engages a female driving plate securely attached to the butt end of the axle by means of two cap screws. The pressure exerted by the steel torsion springs insures a positive driving connection between the cross bar and the driving plate. The entire oil-circulating mechanism is mounted on the box lid, making for simple application and removal; the operation of the lubricating mechanism is in no way affected by either bearing or journal wear or movement of the journal. A 5-in. by 9-in. Disc-Flo unit requires five pints of car oil. At 75 m.p.h. approximately 2¾ pints (80 cu. in.) of oil per minute are used for lubrication, which is less than one-twentieth of the total amount of oil circulated by the disc. Cooler operation is obtained, because the oil is used both as a radiating medium and a lubricant. The lubricating system provides immediate initial lubrication with one-half wheel revolution, and the amount of lubricant circulated increases directly with speed. The oil, analyzed after 25,000 miles of service, was said to be in excellent condition, no emulsification having taken place.



Side view of the Disc-Flo journal box in the truck

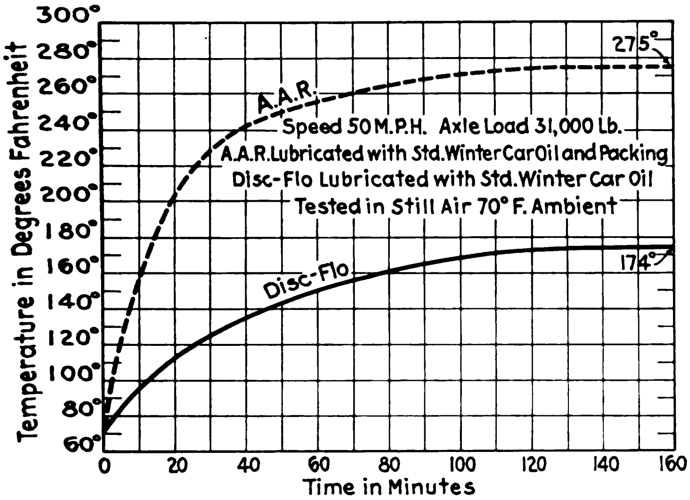
A simple and effective oil seal is held against the surface-ground back on the journal box by a seal cover secured with bolts. This cover compresses the resilient oil resisting ring gasket encased in a special treated washer, the inner edge of which fits around the journal. To keep this seal tight around the journal, a garter spring is secured to bear on it all around the axle, and is arranged so that wearing parts are lubricated from excess oil flowing off the journal. All of these seal parts are mounted on a seal plate. The seal unit is so designed that it will not rotate with the axle, yet permits the necessary vertical movement when the journal box is jacked up for bearing removal.



Cross-section showing details of new journal-bearing unit

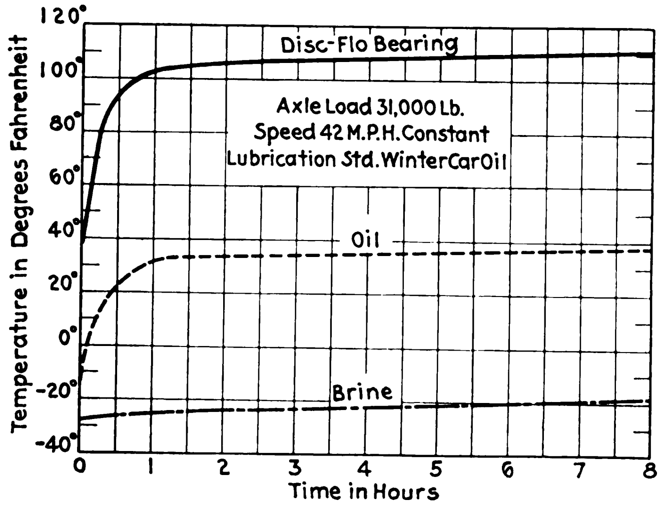
A vent is provided to equalize pressures and to prevent moisture accumulating inside of the box from condensation. A combination oil-filling and inspection cup with a spring lid is used, requiring only a few seconds to gage the oil, which is the only inspection required on Disc-Flo units. It has not been found necessary to add any oil to the original supply of five pints per box on the units now in service for over 25,000 miles.

The pedestal ways on the sides of the journal box are fitted with renewable hardened spring-steel liners. Disc-Flo units are designed to fit present standard axles and pedestals without any changes, and no special tools are required for their application, removal or maintenance.



Comparative temperatures of Disc-Flo unit and A.A.R. bearing

Operating characteristics, as determined from tests under identical loads and summer weather conditions, are said to indicate lower temperatures for the Disc-Flo unit than for the A.A.R. journal box, a reduction in temperature of 20 per cent at low speeds and 35 per cent at high speeds being obtained. These temperature tests were conducted in the laboratory in still air, so, while comparative, they are higher temperatures in both cases than would be secured in actual service. One of the charts shows temperatures of the Disc-Flo and standard A.A.R. journal bearing, these tests being made simultaneously in a Loadometer testing machine, having one end of the axle equipped with the Disc-Flo unit and the other end with an A.A.R. box and bearing.



Cold test of the Disc-Flo unit at 30 deg. F. below zero

By refrigerating the journal boxes, winter temperatures of minus 30 deg. F. were simulated to make a study of Disc-Flo units, using standard car oils. With minus 30 deg. F. box temperature, oil was said to reach a running temperature of plus 37½ deg. F., and the bearing, plus 112 deg. F., with 15,500 lb. load per bearing at 42 m.p.h. on a 5-in. by 9-in. journal. The second chart shows the sub-zero test curve.

Preliminary journal friction tests indicate that Disc-Flo units will have lower friction losses than conventional A.A.R. journal bearings.

Failures of Locomotive Parts

(Continued from page 484)

nearly across the full section before final failure—that the steel was of excellent quality. The life of the pin. however, was extremely short. It was applied January, 1933, and failed April, 1935. It had a life, therefore, of only a little over two years and failed because of the rough turned and scored fillet. It is difficult or impossible to determine whether the score marks were the direct result of the turning of the fillet, but it seemed that the fillet was scored in finishing rather than in service, since evidence of the rough turning was apparent on the torn surface.

From a consideration of these failures of crank pins, it would seem that with a proper finish of the wheel fit and fillets, the life of many crank pins can be greatly prolonged. The use of a rather coarse feed with a properly ground tool, will give a good finish. A study of proper cutting angles for the tools and the use of proper feeds, would appear to promise excellent and profitable results. Are many failures which are attributed to overload, poor design, etc., not possibly due to poorly machined fillets and to pressed fits, or to corrosion cracks where the metal is subject to reverse stresses? The officer of a large plant told me that a certain part that failed had a ground finish and that the failure could not possibly have been due to tool marks. Examination showed that the work was ground up to the fillet; then because of difficulty in grinding the fillet, it was left untouched and showed plainly the marks of the cutting tools. It is not surprising that the shaft broke in the fillet.

Conclusion

In conclusion, I would suggest that consideration be given to the undercutting and under-rolling of a small portion of the wheel fit just within the hub face, and that, if possible, particularly if the part is subjected to corrosion, that cadmium plating be used for additional protection. Corrosion will cut the endurance limit of a steel to 50 per cent of its value and no finish which is subjected to corrosion will give security. Undercutting or under-rolling will eliminate corrosion due to friction. Cadmium plating will eliminate that due to moisture. A combination of these two methods should greatly increase the life of crank pins. It must not be forgotten, however, that the under-cutting and under-rolling must be free from tears in the metal or grooves, and that there must be no square corners.

Caboose Deluxe.—There's a story behind the little red caboose in the yard of former Sheriff Shields of Great Falls, Mont. Its days of wandering are over but, unlike the dismal end of most railroad cars, this one is still on its own wheels and they rest on real rails and ties. The former sheriff happens to be one of the old-time railroaders of the Northwest. But now he's retired. The caboose, however, is not merely a reminder of his period of service for the Great Northern. This caboose, in fact, has gone quite high hat. Its interior has new and strange things mingled with the equipment customarily found in rolling stock of this kind. It's ex-sheriff and ex-conductor Shields' improvement on the fad of turning the basement coal bin into a recreational room.

EDITORIALS

Progress in Weight Reduction

The Chicago, Milwaukee, St. Paul & Pacific passenger-train cars recently built for the "Hiawatha," which are described in this issue, represent an interesting further step in the development of reduced weight equipment which that road first undertook in 1934. In the first designs the weight reduction was obtained by a careful distribution of metal in the structure, by employing welding in place of riveting in construction, and by utilizing light-weight materials for interior finish. A unique feature of the original design was the formation of the side panels in pans which, in effect, made the side sheathing and frame members integral.

The second step, aside from modifications in the details of construction, involves a change from carbon steel to Cor-Ten steel as the material for the underframe and superstructure. The overall result of the changes in material and in the detailed construction is a reduction in weight of the coaches from about 56 tons to 46 tons. With the exception of the stainless-steel coach of the Santa Fe and the aluminum-alloy coaches on the Baltimore & Ohio "Royal Blue" these are the lightest weight coaches fully equipped for long-distance service which have yet been built to dimensions interchangeable with present standard equipment. All of these weights include air-conditioning equipment.

Prior to the advent of the new materials of construction, such as the strong aluminum alloys, stainless steel and the new low alloy structural steels, few, if any, passenger cars for main-line passenger service have been built which do not weigh well over 50 tons. A number of relatively short coaches (62 ft. to 63 ft. body lengths) have been built with weights of 52 to 56 tons. With a few notable exceptions the cars of 70 or more feet in length have weighed from 65 to 80 tons. The Boston & Maine has a lot of 70-ft. coaches which weigh less than 60 tons and the Pennsylvania P70 class coaches have been built with weights running from slightly below to slightly above 60 tons.

Not only have the new materials, therefore, resulted in definite improvements in the weight situation by their application, but they have also stimulated a new interest in refinements in design which are contributing to improvements in the weight efficiency of passenger-car designs irrespective of the materials of construction.

Not the least effective of the factors entering into weight reduction in the lighter weight coaches is the use of the four-wheel truck. Only the lightest of the 70-ft. coaches are carried on the four-wheel trucks. Most of those weighing 65 tons or more are carried on six-wheel trucks, largely for the sake of improved riding qualities, with a resulting material increase in the total weight of the cars due to the trucks alone. With the continued development of alloy-steel springs the higher fibre stresses which they make permissible should provide for the development of improved riding qualities in the four-wheel trucks which, in cars of light and moderate weights, should be equally as satisfactory as is obtainable from present-day six-wheel trucks.

Car and Locomotive Orders

Orders were placed during the month of October (up to and including the 29th) for 22 locomotives, 1,310 freight cars and 5 passenger cars, for domestic use. This brings the totals for the first ten months of the year (excluding the last few days in October), as reported in the issues of the Railway Age, to 180 locomotives, 38,664 freight cars, and 154 passenger cars, to which must be added orders for six light-weight trains with an aggregate of 56 body units, either partially or wholly articulated.

Reference to the table will show that this is more than twice as many, in all instances, as the total orders placed during the entire year 1935. Indeed, the totals up to date for this year measure the high mark for the past six years, except for 1934, when the Pennsylvania Railroad ordered an unusually large number of electric locomotives for its New York-Washington service, and when the Erie and New Haven gave relatively large orders for passenger cars. The totals thus far this year, however, by no means measure up to the orders during the year 1930, and these, again, are relatively small as compared to the average orders for the five years 1925-1929, inclusive. The orders thus far for 1936, how-

Equipment Ordered for Domestic Use

	Locomotives	Freight cars	Passenger cars
1925-9 (inc.), Average	981	78,854	1,980
1930	440	46,360	667
1931	176	10,880	11
1932	12	1,968	39
1933	42	1,685	6
1934	183*	24,611	388†
1935	83	18,699	63
1936 (to Oct. 28 only)	180	38,664	154‡

* 73 of these were electric locomotives for the Pennsylvania.
† 133 of these coaches were for the Erie and 50 for the New Haven.
‡ To this must be added 56 body units in six light weight articulated trains.

ever, do reflect the increased traffic which has been handled by the railroads during the year.

There are now outstanding inquiries for 145 locomotives, 896 freight cars and 18 passenger cars. Action on some of these had been expected before this time, but the supposition is that uncertainties as to the results of the election have held them back. The election will be decided before this number of the *Railway Mechanical Engineer* reaches its subscribers. Railway freight traffic, measured by the weekly reports of the carloadings, has been holding up exceptionally well and during the month of October established high records for recent years. It is quite likely that before the year is closed the figures for equipment ordered will likewise mark an unusually high point.

The Whistling Nuisance

One of the characteristics of our machine age has been the excessive amount of noise—harsh noises in many instances which have been detrimental to health and comfort. The railroads have been among the leaders in this respect.

The detrimental effects of noise have become more and more marked as new forms of transportation have come into being, such as the street car, the automobile and airplane. Fortunately, much scientfic research has been devoted to this problem in congested cities in recent years, and determined efforts are being made in many places to reduce it to a minimum.

One particularly irritating noise, which has brought much criticism on the railroads, has been that of the locomotive whistle. Whistling cannot be avoided, because of the many grade crossings. Attempts have been made, however, to change or improve the tone of the whistle so that it would prove less distressing and disagreeable. Recently the Florida East Coast equipped a locomotive with six different types of whistles. It was run over the road on a special train and demonstrations were given in 19 different cities. Announcements of these demonstrations were made in the press and by other means, and ballots were distributed and as many collected as possible. Apparently it is the intention of the railroad to equip all of its locomotives with the type of whistle meeting with the most widespread approval. At one time, before the research was completed, 95 per cent of the votes were said to favor one particular whistle.

The press gave considerable attention to this unique experiment, and the whistle which was most widely favored at the time was characterized by one newspaper commentator in these words: "Anyone who has ever been awakened at two o'clock in the morning on an ocean voyage by the bellow of a fog horn, will recognize it in a moment." Another whistle was said to be "harsh toned and shrill; its merest utterance made you feel as if you would like to go out and fight a policeman." Another was likened to a "high shriek of agony across a wilderness at nightfall." Incidentally, these comments refer to whistles of the steam type. Three other whistles were operated by air. Apparently they did not meet with approval. One of them, for instance, was likened to a "factory whistle resounding at the close of day across the rooftops of a crowded city"; another as a "dying calf siren, hardly audible two squares away." The tones of another whistle of this type "evidently died on the way, as none reported having heard it."

The Florida East Coast is to be commended on this effort to provide a whistle which will prove effective in service and yet will produce a minimum of irritation. The American public, particularly in the vicinity of our large cities, is showing a disposition to be exceedingly critical of all unnecessary noise. It therefore behooves the mechanical departments of our railroads to give special attention in the designing of locomotives and cars, to insure that every possible step is taken to insure their operating as quietly as possible. It will be better to anticipate a growing antagonism on the part of the public toward nuisances of this sort, and take constructive measures to improve conditions before they reach a point which will result in controversy and retaliation on the part of the public.

Competition in Equipment Design a Sign of Progress

Most of the men in positions of responsibility in the mechanical departments of American railroads today have not forgotten the statements of some of the enthusiastic proponents of electrification about twenty years ago to the effect that the day of the steam locomotive was over and that it would only be a matter of time before most of our railroads would be electrified. What has happened since is a matter of history. The steam locomotive is still with us and, in spite of the fact that during the past twenty years its development has been the most intensive of any similar period during the hundred years of its existence, its supremacy is now being challenged again. The Diesel has entered the picture and even in the comparatively short space of five years the progress that has been made has caused some to suggest that steam is decidedly on the defensive. Now, within recent months, back comes steam in the form of the turbo-electric, such as the Union Pacific proposes to build, and the high-pressure rail train, such as the one on the New Haven described on page 485 of this issue, to challenge the right of the Diesel to monopolize the transportation scene.

All of these forms of rail motive power will eventually find only that place in the railroad scene which can be earned by proof of their economic value. What

is important is that the railroad industry has the vision not to dismiss any new form of motive power which is offered to them without a thorough trial to disclose its possibilities. Out of these trials are developing new tools which do not displace the older and time-tried implements of the industry, but rather supplement them. The result is a change in emphasis toward specialization and away from standardization, the stimulating effects of which are being felt not only throughout the railway organization, but also by the public.

Accidents Are Costly

F. H. Williams in his article on Failures of Locomotive Parts, elsewhere in this issue, confines his comments to the crank pin, and only to that part in the wheel fit or immediately adjacent thereto. Researches have shown, to his own satisfaction, at least, that the utmost care must be given to insure the elimination of even minute surface imperfections in the machine finish. Is this worthwhile?

It seems to be the impression that crank pins usually fail when the locomotive is starting or stopping, and not when it is operating at high speed. Whatever the facts may be in this respect, it is a matter of record that crank pins do fail when the locomotives are operating at high speed. Such an accident on an eastern railway recently resulted in damage to the extent of $30,000.

Mechanical-department officers are seriously concerned with this problem of the breakage of crank pins. Certainly, the direct cost of such accidents to the railroads today is so great that unusual pains can well be taken to avoid them. If Mr. Williams is right in his contention, then his recommendations should be followed; if he is wrong, the sooner it is determined, the better, in order that effective measures may be taken to eliminate the weakness. Is he right? Is he wrong?

NEW BOOKS

LOCOMOTIVES. *By A. M. Bell. Published by Virtue and Company, Ltd., 19-21 Thavies Inn, Holborn Circus, London, England. 424 pages, 9 in. by 11 in., 2 volumes, cloth binding. Price 37s. 6d.*

In these books (second edition) the author takes up the subjects of steam locomotive construction, maintenance and operation. After this, in a briefer manner, sections are included on electric, internal-combustion and other forms of motion power. Both volumes are well illustrated by line drawings and half-tones. Several are on large size, folded sheets and a number are printed in colors. The frontispiece—on a sheet 11 in. by 19 in.—shows a phantom sectional illustration of the "Lord Nelson," a four-cylinder 4-6-0 express locomotive of the Southern Railway (Great Britain) on which 260 parts are numbered and named.

Volume I is devoted mainly to matters of design and construction of detail parts, as indicated by the nine chapter headings which are as follows: general description, boiler, superheating, cylinders and valves, framing and wheels, lubrication, tenders, continuous brakes, feedwater. In Volume II the subjects are: repairs, maintenance, combustion and fuel, running faults and failures, shop arrangements, enginemen, special types of steam locomotives, internal-combustion and electric types, modern types of locomotives. Among the special types illustrated and described are turbine locomotives, Beyer-Garatt articulated, Franco articulated and condensing locomotives. The modern locomotives chosen are those on British roads or those built by British companies for export.

While these books do not deal with American locomotives or with shop practices in this country, they yet contain much of general information, particularly to younger men. An excellent index is given at the end.

CORROSION RESISTANCE OF METALS AND ALLOYS. *By Robert J. McKay and Robert Worthington. An American Chemical Society Monograph published by the Reinhold Publishing Corp., 330 West Forty-second street, New York. 492 pages, 6 in. by 9 in., illustrated. Price, $7.*

The purpose of this work is to summarize the facts on corrosion processes and rates. Data from experience and test on the action of alloys, under given conditions, form the main part of the book. The preliminary part attempts to classify and explain the important points of the general theory and mechanism of corrosion. While the data offer no panacea for corrosion difficulties, a combination of data from Part II with the general facts of Part I should enable the reader to reason for himself on corrosion problems on which direct information is not available. The materials which are dealt with in Part II are magnesium and its alloys, aluminum and its alloys, zinc and zinc coatings, cadmium plate, tin and tin plate, lead, iron and steel, silicon-iron, molybdenum and chromium plate, nickel and nickel-iron and nickel-copper alloys, copper and high-copper alloys.

DICTIONARY OF MECHANICAL ENGINEERING TERMS. *By J. G. Horner, A. M. I. M. E., and E. H. Sprague, formerly M. I. M. E. and A. M. Inst. C. E. Published by the Technical Press, Ltd., 5 Ave Maria Lande, Ludgate Hill, E. C. 4, London. Price, 12 s. 6p.*

The Appendix to this sixth edition of the (British) Dictionary of Mechanical Engineering Terms, comprising approximately eight thousand definitions of terms used in the theory and practice of mechanical engineering, has been enlarged to include several hundred additions relating to the advances in engineering practice. Only terms of universal, or of moderately wide application are defined.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

One Satisfied Subscriber

May I say that I owe your magazine a lot in getting my promotion. After subscribing to and reading it for several months I had occasion to talk with the road foreman of engines. I was then a valve setter in the roundhouse and our discussion revolved about engine repairs. I had read a number of good articles in the magazine that gave me some constructive ideas and these were passed on to the road foreman, with the result that I was promoted. I have since found the *Railway Mechanical Engineer* helpful, in that it keeps me abreast of the times. I am not much of a hand at reading magazines, but I can't wait until your next issue gets to me, and I literally "eat it up."

Poor Salesmanship

Some time ago I received a form letter suggesting that I "wake up" and discover for myself, as so many other progressive industrialists had already done, that their machine would cut down costs at least 50 per cent, and that the entire cost of the machine might be recouped in a year, since it was so much more efficient than the one we were using. My reply to this was: "If your advertising department was as wide-awake as your sales department you would know that several years ago we installed one of your machines, purchased through reading a very intelligently written description of it in the advertising pages of a well known technical magazine. But, if this advertisement had made the absurd claims found in your circular, we doubt very much if it would have interested us at all. Your machine is giving very satisfactory results and is all your salesman claimed, but it would take several years to pay for it with the savings made. You should know this particular machine could not possibly be used but a small proportion of the time in a shop of our size; in fact, it is not used more than 25 per cent of the time. When it is in use it is possible to perform the work about 10 per cent faster than the machine it displaced, and it only displaced the old one because of its having been in service 28 years. We are satisfied with it and possibly were 'awake' before the writer of the circular was employed to write it."

A "Budding" Foreman

Some of the younger men in our shops feel that the older supervisors should retire at 65 years of age in order to give them a fair chance. One who appeared to be feeling the worst over it—who claimed to have given the matter of adequate supervision much study, and had taken a part course on the subject and felt his time wasted if he never got an opportunity to demonstrate his ability—was recently given a two weeks' trial, when one of the foremen was on a vacation. Meeting him one day, the superintendent of shops asked him how everything was going along.

"Fine, sir; very fine, indeed."

"Well, I'm glad to hear that Joe. But do you know that some months ago it was decided to discontinue using a file on our lathe work; that a better job would be made with a tool, if proper care and skill were used?"

"Yes, sir, I do," the young man replied. "Old Bill, my foreman, discussed that with me at the time and I quite agreed with him. And in one of my lesson papers, it——".

"Never mind the lessons just now, Joe. I passed by the man on the crank pin lathe over there about 10 minutes ago and he sure was busy with his file. You can see from here he is still filing."

"Well, I didn't happen to notice it, but I'll go over and tell him about it."

I later learned that this is in part what was said by Joe: "Say, you big So-and-So, the Old Man has been watching you filing that wheel fit for several minutes. You know as well as I do that filing is out. He's just bugs on that subject. Keep your eyes open when he's around. I just got hell over it."

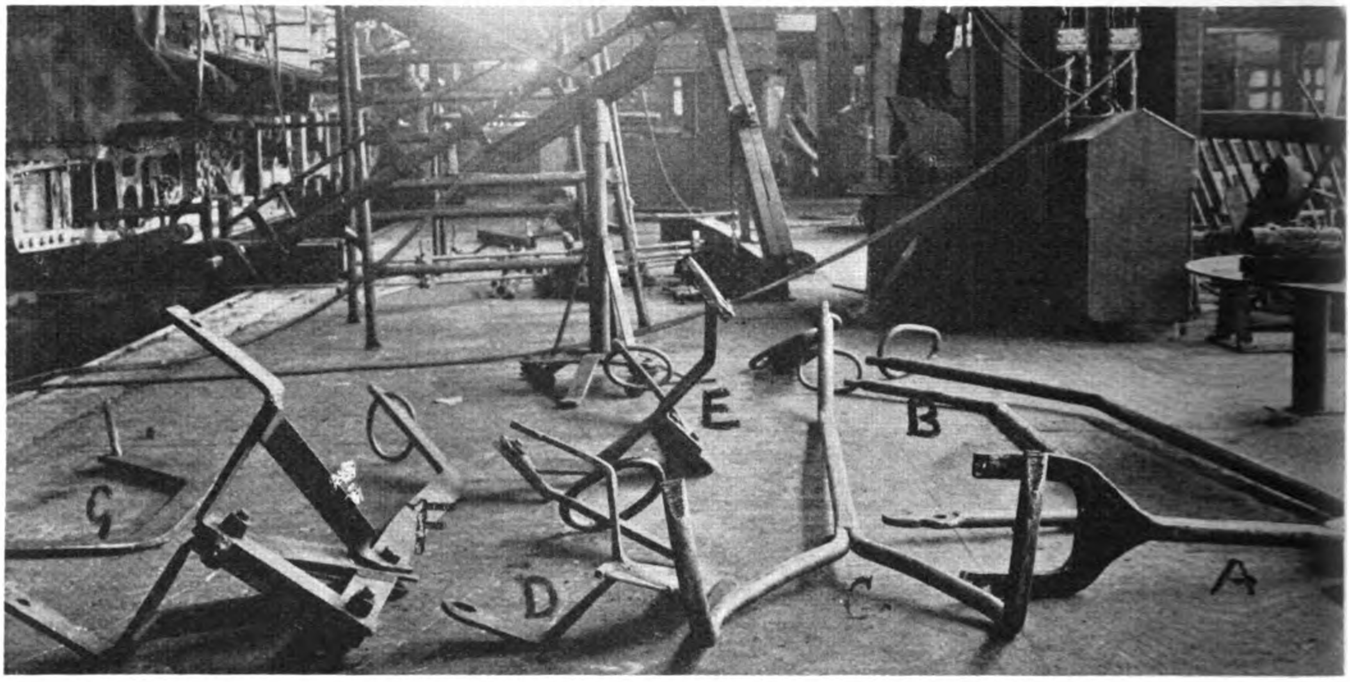
I later called Joe in and had a heart-to-heart talk with him. He admitted it. But I wonder if any reader, a budding foreman especially, would care to say what he thinks was said to Joe, or will anyone say just what he thinks Joe should have been told.

Photo by H. C. Wilcox

A Critical Moment

Noon-hour recreation in the wheel shop of the New Haven at Readville, Conn.

IN THE BACK SHOP AND ENGINEHOUSE



Several different types of crane hooks used in applying locomotive parts at the C. B. & Q. shops, Denver, Colo.

Material Handling Devices At Denver Shops

One of the notable features of the large locomotive shops of the Chicago, Burlington & Quincy at Denver, Colo., is the unusual number of special devices developed in the course of the past few years to save time and labor in handling locomotive parts in the erecting shop. Several of these devices, resting on the shop floor, are shown in one of the illustrations.

For example, the spring lifter *A* can be suspended from the crane hook and used by one man in applying or removing driver and trailer springs. The device consists essentially of a hook made of 2½ in. round steel, bent at two places to 45 deg. and 90 deg. angles, respectively, and having a pair of jaws welded to one end to engage the spring. These jaws are spaced 15 in. apart and it is approximately 54 in. from the jaws to the link in the other end, which engages the crane hook. The right-angle bend in this lifter is stiffened by welding to it a triangular plate made of ⅜-in. steel, 15 in. long on each leg of the triangle.

At *B* in the illustration is shown a similar but smaller crane hook made of 2-in. round stock with a link in one end and the other slightly flattened and provided with a drilled hole to engage a bolt in the back valve chamber head and be used when applying or removing this somewhat awkward-shaped locomotive part.

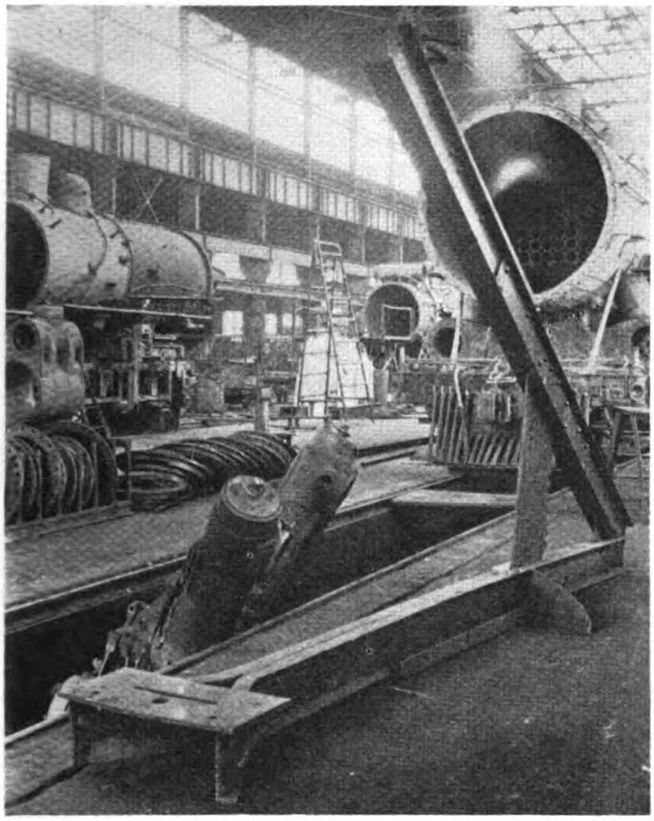
The usual type of air reservoir lifting device is shown at *C* in the illustration, being 15½ ft. long, lifting arms spread 32 in. apart, and made of 3-in and 2-in. stock. This device is spring-supported from the shop crane to avoid possible damage to reservoir bracket studs or breakage of the hook, due to over-travel of the shop crane in lifting. Devices of the same general character, used in lifting 11-in. and 8½-in. air pumps are shown at *D* and *E* in the illustration, being made of 4-in. by ¾-in. steel, and having lifting arms arranged for convenient attachment to the pumps.

The device shown at *F* in the illustration is a strongly-made and rigidly-braced hook for use in applying cross-head and guide assemblies. This device is made of 4-in. by 1-in. stock, 8 ft. long from the link to the lifting arms which are spaced 32 in. apart and provided with round holes in the ends for secure attachment to the crosshead and guide assemblies.

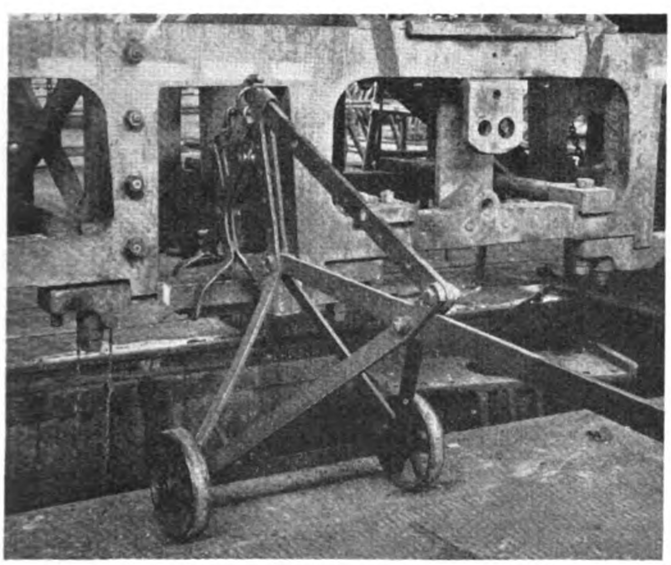
A special hook for use in applying Elesco feedwater pumps is shown at *G* in the illustration, being made of 4-in. by 1-in. flat stock. Incidentally, the back ground of this picture shows a washout-hole reaming device, very effectively used for reaming and tapping out washout and arch tube plug holes. The device is driven by a reversible pneumatic motor arranged to drive the drill or tap socket through an adjustable power shaft 10 ft. long and equipped with a 1-to-20 worm-gear drive on the lower end.

A very satisfactory binder-lifting device, mounted on two wheels and provided with a 12-ft. handle to give the necessary leverage, is shown in a separate illustration. This device is made in general of ¾-in. stock 2 in. and 3 in. wide, the special binder clamps being supported by chain links from a hook which is about 45 in. from the floor. The upper triangular bars of this device are provided with holes spaced so as to make the lifting hook adjustable for height to meet the requirements of various classes of locomotives. By the use of this lifting device, a heavy locomotive binder may be taken from the floor and placed in position on the pedestal jaws ready for application of binder bolt nuts by one man.

Still another device used in applying stokers, superheater headers, etc., is shown in another illustration. This device consists of an A-frame, each leg of which is made of two 9-in. channels bolted together and having the outer ends of the lower channels spread and equipped



A-frame which greatly facilitates removing or applying stokers, superheater headers, etc.



A convenient device for applying binders

with a ¾-in. steel plate 14 in. by 29 in. to which the superheater header can be bolted. The bottom channels are 16 ft. long and the angular channels, to the upper end of which the crane hook is attached, are 14 ft. long. The steel cross plate of the A-frame is made of ½-in. stock 17 in. wide and the angle at the junction of the 9-in. channels is approximately 35 deg. The steel plate to which the crane U-bolt is attached is provided with a series of holes drilled 2½ in. apart so that the point of attachment to the shop crane may be varied, dependent upon the weight being lifted.

This and numerous other lifting devices used at the Burlington shops are designed not only to permit applying and removing locomotive parts with a minimum expenditure of time and labor, but also to make sure that this work is done with maximum safety. There is always more or less potential danger when applying or removing heavy locomotive parts, but the use of properly designed lifting devices, such as those illustrated, removes most of the physical labor otherwise necessary, prevents the possibility of strained backs and limbs, and avoids the necessity of shop men getting into relatively dangerous positions.

Gage for Setting Tires On Wheel Centers

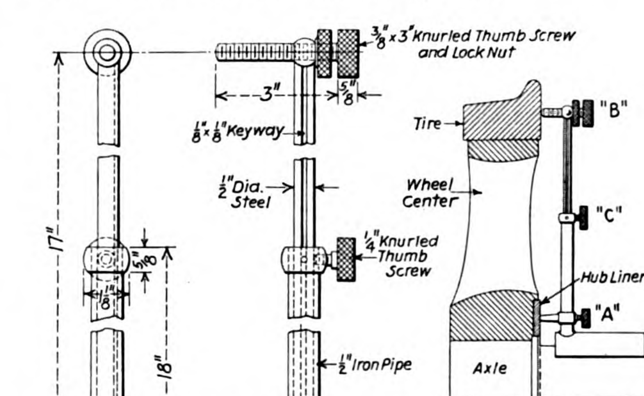
Locomotive tires that have been set on the wheel centers by a slip-shod method usually cause delay and waste of material when the wheels are placed in the wheel-lathe for truing the tires. If the tires are cocked the forming tool will not cut a true flange; therefore, the wheel must be returned to the floor and the tires reheated and adjusted on the centers.

To overcome this delay the gage shown in the drawing was made and is used to set each tire square with the journals and axle center line. If the gage is used with reasonable care, the tire will run true when placed in the wheel-lathe, also the tires will gage equal distances between flanges.

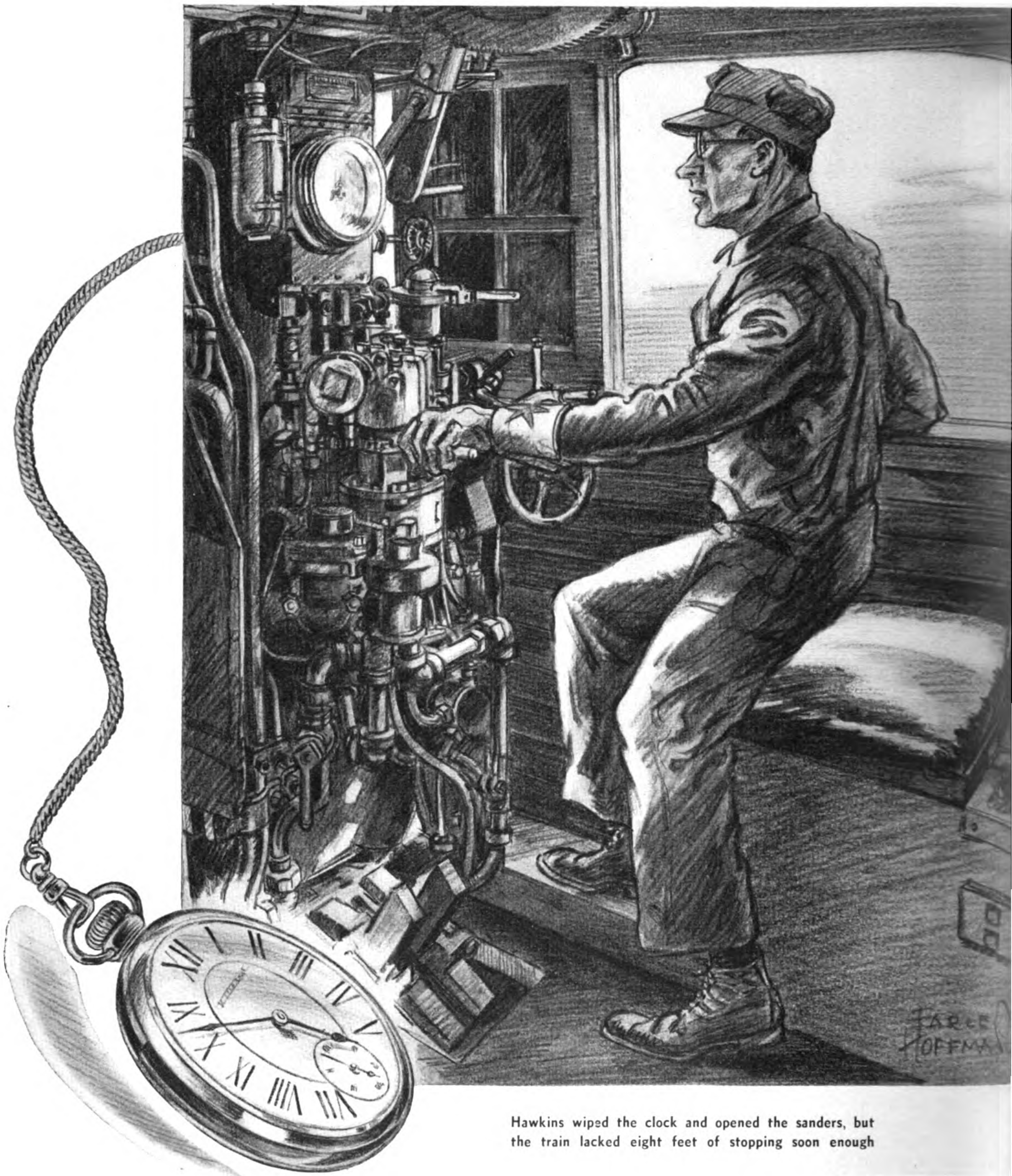
The construction is simple. The dimensions shown are all that are necessary to build the gage for all size locomotive tires.

There are three adjustments, *A* at the hub liner, *B* at the tire and *C* for the height. The distance between the hub liners is measured with a slip tram and this distance is subtracted from the back-to-back distance between the tires, that is 53⅜ in. or 53¼ in. Should this distance show that the tires must be set ⅛ in. wider than the hub liner faces, adjust the pointer *A* to center of hub liner and adjust the screw *B* until it is 1/16 in. longer than *A*, then adjust the height of *B* by the set screw *C*. While the tire is hot and with the angle iron base on the journal, slide the jig until the pointer *A* is touching the hub liner and adjust the tire to touch the pointer *B*. When the opposite tire is applied, use a 53⅜-in. or 53¼-in. tram between the tires, checking four or more different points around the tires.

This method will set the tires square with each other as well as with the axle centers, thus eliminating any further trouble to the wheel lathe operator.

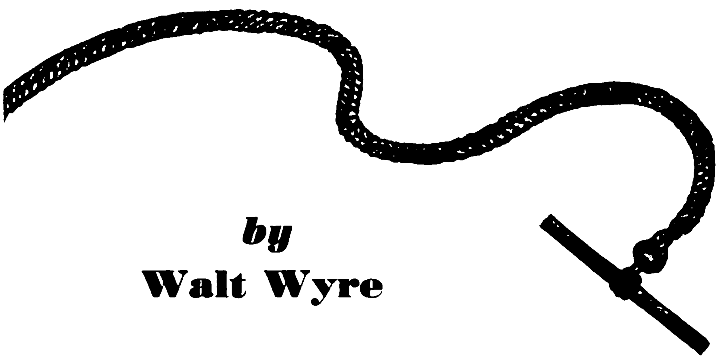


Details of gage used for locating tires on the wheel centers



Hawkins wiped the clock and opened the sanders, but the train lacked eight feet of stopping soon enough

Trains Can't Make Time STANDING STILL



by
Walt Wyre

A new time-card was out on the S. P. & W.—a time-card with schedules faster than most any one had dreamed possible a few years back. Everything was speeded up. The Limited, already considered pretty fast, had six hours lopped off the time between Chicago and the Pacific coast. Freight trains showed a scheduled time that was the boast of crack passenger trains not long ago. Division superintendents that had been in on the new schedules wondered if it would be possible to make the time. It looked less possible when seen in the obdurate figures of the time-card than when being discussed.

Superintendents had agreed that with all conditions favorable the time could be made over their respective divisions when the time-card was being considered. Some of them may have had their fingers crossed and a prayer in their hearts that they would never have to demonstrate the fact when they concurred with the general manager that such speeds were entirely possible. Then, too, the power of suggestion goes a long ways, particularly when it's the general manager doing the suggesting and he intimates that any who fail to agree with his suggestion might be given the opportunity to look for more amenable superiors.

At any rate, all of the superintendents agreed that the schedules indicated were entirely possible. Some of them voiced mild protests that became weaker under the glare of the g.m. Now that the schedules were an established fact and the general manager miles away, many of them wished they had protested more violently. If they had it to do over, they would, they told themselves. Besides, it wouldn't be any worse to get demoted for failing to agree than for failing to run trains on impossible schedules.

Trainmasters, when they received the new time-card, looked it over and scratched their heads. Most of them reached for a pencil and pad of clip and began to try to figure how minutes could be clipped off the time required to get trains through terminals. The less optimistic ones thought of how it would be back on their old jobs that they had before being promoted.

Master mechanics shook their heads and asked for the last engine failure report, not that any of them needed the report to tell just how many engine failures had occurred on his division the past thirty days. If there were too many to remember he had already made arrangements to move to a less responsible position. Ones that had a bad record of engine failures wanted to figure how many more would be too many. Ones that had a record showing few failures or none wanted to see how the record would look with a flock added on. All of them figured that at the best engine failures would be more numerous and the assumption was reasonable. Increased speed meant increased wear on moving parts and more friction to cause hot pins and hot boxes.

The Plains Division received the hardest jolt of all with the new time-card. Train speeds already fast were stepped up so high that it seemed throttle quadrants would have to be lengthened if the trains made the time.

T. E. McGinnis, superintendent of the Plains Division, voiced a protest when the schedules were suggested.

"But, Mr. McGinnis, your division is almost as level as a floor and straight as a string. The road bed is as good as can be found and with that new heavy steel —of course, if you think we are too out of date—."

McGinnis knew that the g.m.'s "we" wasn't intended to be plural at all. The superintendent caught the drift and said no more.

The schedule went into effect Sunday at 12:01 a.m. and the trouble started.

Seventy-one and 72's "on time" performance record looked like a tank-town college football score against S.M.U. At first the super received letters merely suggesting that it was very important for the Red Ball freights to run on time. Evidently the locomotives had never heard of Coue, or whoever the Frenchman was that expounded the theory of "every day in every way, I'm getting better and better," for "on time" performance didn't improve. The superintendent called a meeting of the trainmaster, master mechanic, and road foreman of engines.

"Gentlemen," the superintendent drummed nervously on his desk with a pencil, "you all know that our 'on time' performance has been er—ah—deplorable."

H. H. Carter, the master mechanic, nodded approvingly. Deplorable was the word he would have used, and did, at every opportunity.

"The performance is deplorable. There's something wrong. What we want to do is find the trouble and correct it." The superintendent glanced questioningly at the three men seated across the table from him.

"Well, we're doing our best getting the trains through the terminal," Wally Robinson, the trainmaster, said, "and making pretty good time at it, too," he added, which shifted the responsibility.

"How are your locomotives?" McGinnis looked at Carter.

"Our power is in pretty good shape. In good shape, I'd say. Our record of engine failures—only two last month—speaks for itself." The master mechanic spoke very emphatically.

Bob Lane, the road foreman of engines, squirmed uneasily. Everything else was going good, which left it up to him. He didn't wait to be questioned. "Well, it looks to me like a case of too much trains to make the time. You know, there's seldom less than ninety cars on 71 or 72 and the time is pretty fast."

"Yes, the time is pretty fast, but so are the locomotives, and they're not pulling more than their tonnage," McGinnis interrupted. "I want you to ride the engines, and you, too, Carter, and find out why they're not getting over the road. And you, too, Robinson, ride the trains, particularly 71 and 72. I'm going to ride them, too. Other divisions are making the time and there's no reason why we can't." The super glared as though he dared either of them to deny it.

After a little further discussion the meeting adjourned with nothing more definite determined than that each official and department was doing the best job of railroading possible and the trains were not consistently making the time.

The trainmaster rode the trains; the master mechanic and road foreman rode the locomotives. Nothing happened except the officials got behind with their sleep.

Then business took a seasonal slump and trains were lighter. Seventy-one and 72, instead of being 90 to 100 cars or more, were cut to 60 and 70 cars and made the

time. Twenty-eight hundred class locomotives made the run with less effort than the 5000's had made it with the heavier trains, which didn't check according to their respective ratings.

"It's them 500 engines," the trainmaster said. "They're not what they're cracked up to be!'

"Like hell it is!' the master mechanic snapped. "They're good engines; if they weren't, they wouldn't stand the beating they get pulling sixteen coaches on the Limited, half of them Pullmans, air-conditioned, too."

"Well, it's quite evident there's something wrong," the superintendent cut in. "The 2800's are making the time with their rated tonnage and the 5000's didn't do it. Perhaps there's something in what Robinson says. Maybe the locomotives in passenger service are in better condition than the ones used on freights."

Carter made a rumbling sound in his throat when he swallowed the retort that was on the tip of his tongue. "Well, I'm going to find out what the trouble is when business picks up—and it won't be the locomotives, either!"

The opportunity came sooner than expected. Two weeks later there was an unexpected demand for grain cars in Kansas. The current wheat crop was light, due to drought conditions, and no one looked for a heavy wheat movement. A sudden upturn of the market brought a rush of wheat out of storage and elevator operators were yelling for cars, and they wanted them right now.

Seventy-two, that usually carried nothing but hot-shot merchandise and perishables, was filled with empties.

Carter was at his desk frowning at the amount of overtime worked in the Plainville roundhouse the previous month, when the phone rang.

"Yes, this is Carter," the master mechanic snapped. "Oh, yes, Mr. McGinnis."

"Train 72 lost an hour and forty minutes yesterday," the super said, "with a 5000 pulling it."

"How many cars?"

"Hundred and two—sixty-five empties," McGinnis told him.

"I'll ride 72 this afternoon," Carter replied.

"Let me know how you make out," the superintendent replied.

Seventy-two was due to leave Plainville at 2:45. According to the lineup, it would get in about 2:10 with 48 loads with a 2800 pulling it. Fifty-five empties were to be added to fill at Plainville.

Carter went to the roundhouse before noon to see what engine was being used on 72 and what condition it was in.

"Figuring on using the 5084," Evans, the roundhouse foreman, told him.

"Why not use the 5091? Ain't she a better engine?" Carter asked.

"Yes, but I figured to use her on the Limited." Evans bit off a hunk of "horseshoe." "The 5091 is a good engine."

"Use her on 72."

Evans turned his quid of "horseshoe" with his tongue. "O.K.," he said.

The master mechanic looked over the 5091 like a government inspector with a grudge against the roundhouse foreman. He even looked at the tank box packing and crawled underneath the engine. He found a screen that didn't fit the journal to suit him and had it replaced.

At 2:45, Shorty Hawkins, the engineer gave two inquiring toots of the whistle. The car inspector waved his hat—O.K. The conductor standing by the engine said, "High-ball," and started walking back towards the caboose. The hoghead shoved the air reverse lever all the way ahead and opened the throttle. With the booster helping, the train started almost as smoothly as a switch engine with the President's business car. The head brakeman waiting at the switch let them out on the main line. He caught the engine and climbed aboard. The rear brakeman would close the switch.

Gradually the train picked up speed, Shorty Hawkins working a light throttle. When all but about ten cars were on the main line, the engineer closed the throttle and let the train drift. The brakeman dropped off the front steps of the caboose to close the switch. The instant the caboose was in the clear, the shack swung on the switch lever.

"What do you say? Is he ready to go?" Hawkins asked the fireman.

"Seems to be having trouble closing the switch," the tallow pot replied over his shoulder. "He's giving a stop signal."

The engineer looked at the ground. The train was rolling faster than he thought. With the train a few car lengths ahead of him, the brakeman would have a hard time catching it. The hoghead applied the air lightly, just enough to drag the brake shoes on the rolling wheels.

In the meantime, Carter was leaning anxiously out the gangway, craning his neck to watch the brakeman. "You'll have to slow down more or he'll never make it," the master mechanic said. "He's got it—he's running after the caboose—nope—he's give up."

The engineer again applied the air, making a reduction of about ten pounds.

The rear brakeman waved his cap with one hand and caught the grab iron with the other.

Hawkins widened on the throttle a couple of notches. There was a slight jerk as the slack ran out on the head end cars; still the train got slower. He opened the throttle wider. The drivers spun. He closed the throttle and opened the sander valve. Again he opened the throttle and cut in the booster. The train continued to lose speed.

"What's the trouble?" Carter asked anxiously.

"Damned brakes dragging. Must be some bad leaks in the train line." Hawkins closed the throttle and the train stopped almost immediately.

"Won't she pull it?" Carter asked.

"Yeah, she'll pull the ones ahead of where the brakes are sticking and take a draw-bar with 'em if I give her the gun," Hawkins replied as he "hossed" her over in reverse to take slack again.

He waited a minute and tried again. The train started reluctantly, dragging hard for two or three minutes.

Carter looked at his watch. "Five minutes or more lost getting out of town on account of a brakeman being slow." The master mechanic made a notation in his little black book.

"Account of brakes being slow, you mean," the engineer yelled as he pulled the reverse lever a couple of notches nearer center. The master mechanic scratched his head, then made another notation in the little black book.

Gradually the speed increased. The exhausts from the locomotive became a staccato bark as the hoghead hooked her up that blended in a roar as the speed increased. The master mechanic looked over at the hoghead and grinned. They were rolling along.

By the time 72 reached the caution signal for the Santa Fe crossing at Guys, thirty-eight miles out of Plainville, the train had made up the lost time. The engineer closed the throttle and allowed the train to slow down to about thirty miles an hour. He leaned out of the cab and peered ahead for the crossing block signal. It indicated stop.

Hawkins applied the independent engine brakes grad-

ually to let the slack run in and he prepared to stop unless the signal cleared in time. He waited as long as he dared and applied the brakes. "Clear ahead!" Carter yelled as the signal changed.

But it was too late to keep from having to stop the train. The engineer slid to the ground and started looking around the engine. The master mechanic followed.

"Let's get going," Carter insisted. "We're losing time."

"Well lose more than that if we tried to start before the brakes are released."

The fireman stayed in the cab. The head brakeman dropped off before the wheels stopped rolling and started walking back towards the rear of the train. When about ten cars back, Carter saw him bleed the air off a car. The rear brakeman was coming towards the head end.

Carter fidgeted nervously while Hawkins puttered around the engine. After what seemed an hour to the master mechanic, the engineer climbed aboard and gave two long toots from the whistle. The rear brakeman finished bleeding the air from a car and waved a highball.

When the train reached Marlowe, twelve miles away, it was twenty-two minutes off on schedule time. That threw them on short time for a wait order and they ran into a red board at Middleton. The order at Middleton gave them more time on the wait order but cost another five minutes slowing down to pick up the order.

Carter made some more notes in his little black book.

Seventy-two had lost thirty minutes when they stopped for water at Beaver. The engineer made a nice stop and very little time was lost at the tank.

"How about making up a little time between here and Sanford?" Carter inquired at Beaver.

The engineer squirted a little oil on the right guide. "Can't do it . We'll be lucky if we don't lose more time."

The hoghead was right. They did lose more time. At Monroe, a city ordinance prohibits speeds of more than 20 miles per hour. The city Dads got sore when the Limited quit stopping there and passed the ordinance to get even. It doesn't hurt a light train so badly, but 72 lost at least another nickel's worth of time before it was again up to speed.

Hawkins had them rolling good about five miles out of Sanford, when he sighted a herd of cattle grazing on the volunteer wheat along the track. Orders are very definite: Do not kill any cattle when it can possibly be prevented. Hawkins didn't kill any cattle, but he did kill some very valuable time. A thick-necked Hereford bull defied the tooting whistle and hissing cylinder cocks by standing in the center of the track until the front coupler of the locomotive was almost touching the stubby horns of the white-face.

Again there was a wait for the brakes to release while Carter walked miles in the narrow confines of the engine deck.

The train was almost in to Sanford and almost an hour tardy on schedule time in spite of the fact that 5091 was performing nobly under the expert hand of Shorty Hawkins. He had her ears pulled back and was rolling along when he sighted a section laborer slowly waving his arms. The engineer closed the throttle and applied the independent air. When the slack was in, he made a service application.

As the train approached the section laborer he began to wave his arms faster until he looked like he was giving a pantomime of a Dutch windmill in a high wind.

Hawkins wiped the clock and opened the sanders, but the train lacked eight feet of stopping soon enough. The left front driver just barely eased to the ground where a rail was out. In the distance the rest of the gang of track laborers could be seen coming lickety-split with a rail to replace the one taken out. The one left behind to flag figured he had walked far enough.

"Why didn't you big-hole her?" Carter asked the engineer.

"Big-hole her?" Hawkins asked.

"Yes, make an emergency application," Carter said.

"I would if I'd known part of the track was gone, but after I made a service application it was too late then. You can't make an emergency application following a service application," the hoghead said, "—not with K-type triples."

Out came the little black book and Carter made another notation.

Seventy-two reached Sanford two hours late. That was the end of the engineer's run. The master mechanic had enough. He decided to let the next engineer take the 5091 without him. They walked over to the station together.

"What are you going to charge the delay to?" Carter asked.

"Time lost stopping," Hawkins replied, "and getting on the ground," he added.

"Couldn't getting on the ground have been prevented?" Carter asked.

"Yeah, if the snipe had flagged us sooner or if we had new type brakes so I could have big-holed her after making a service shot."

Carter made another note in his book.

NEXT day back in Plainville, Carter went to his office early. He barely stopped at his desk along enough to glance over his mail. He laid it all aside to be answered later except a traingram from the superintendent wanting to know about the delay on 72 the day before.

The master mechanic stuck the traingram in his pocket and went to some shelves in one corner of the office and began digging through a pile of magazines, books, and pamphlets. Most of them he laid aside; an occasional one he laid on the desk. When he had finished he had a dozen or more on the desk. Over two hours he spent looking through these and making notes.

About 10 o'clock, the phone rang. "Superintendent wants to talk to you," the clerk said.

"Tell him I'll be right over." Carter gathered up his notes and started.

"Well, it looks like Robinson was right about the 5000's not being able to make the time," McGinnis said in an 'I told you so' manner.

Carter's face reddened. "It's not the engines. It's the air brakes."

"The brakes! Why don't you fix them?"

"I don't mean on the locomotive. On the cars—they're out of date."

"They'll stop the trains, won't they? Besides, we don't want to stop 'em, we want to run 'em." McGinnis smiled drily.

"I set out to find out why our long trains don't make the time, and I believe I know," Carter persisted. "It's not the power, it's the brakes."

"But—" McGinnis interrupted.

"Just a minute, please, Mr. McGinnis. Wait until I finish." Carter piled a stack of papers on the desk topped with the little black book. "The type 'K' air brake equipment was a blamed good brake twenty-five years ago. If it hadn't been for it, railroads wouldn't have attained the speeds they have. It's still a good brake for short trains, but railroad operation of today demands long freight trains at high speed."

"I suppose you're going to suggest equipping all our

freight cars with 'AB' equipment. If you are, it's out of the question."

"No, I'm not going to suggest anything, but I'm going to give you the facts as I see them and let you make whatever recommendations you choose." Then Carter started in.

He told of the delays occasioned on the previous trip and how for the most part "AB" equipment would have prevented most of them, the derailment that might have been a serious wreck and cost enough to pay for equipping many cars with the improved brake.

"But they cost money—they're expensive to install," the superintendent said a little weakly when Carter had finished explaining.

"That's true. 'AB' equipment costs something, but it's not money wasted, it's invested. If I'm right in my opinion, and its partly based on experiences of ones in position to know, the AB brakes, in addition to allowing better running time would save enough to pay for themselves in a few years. "Look these over when you have time." Carter pushed the stack of papers and books toward the superintendent.

"Well, at least, you've given me something to think about and something to tell the general manager when I go in to the office next week to explain why we can't make the time on the Plains Division." McGinnis smiled wryly and reached for a letter.

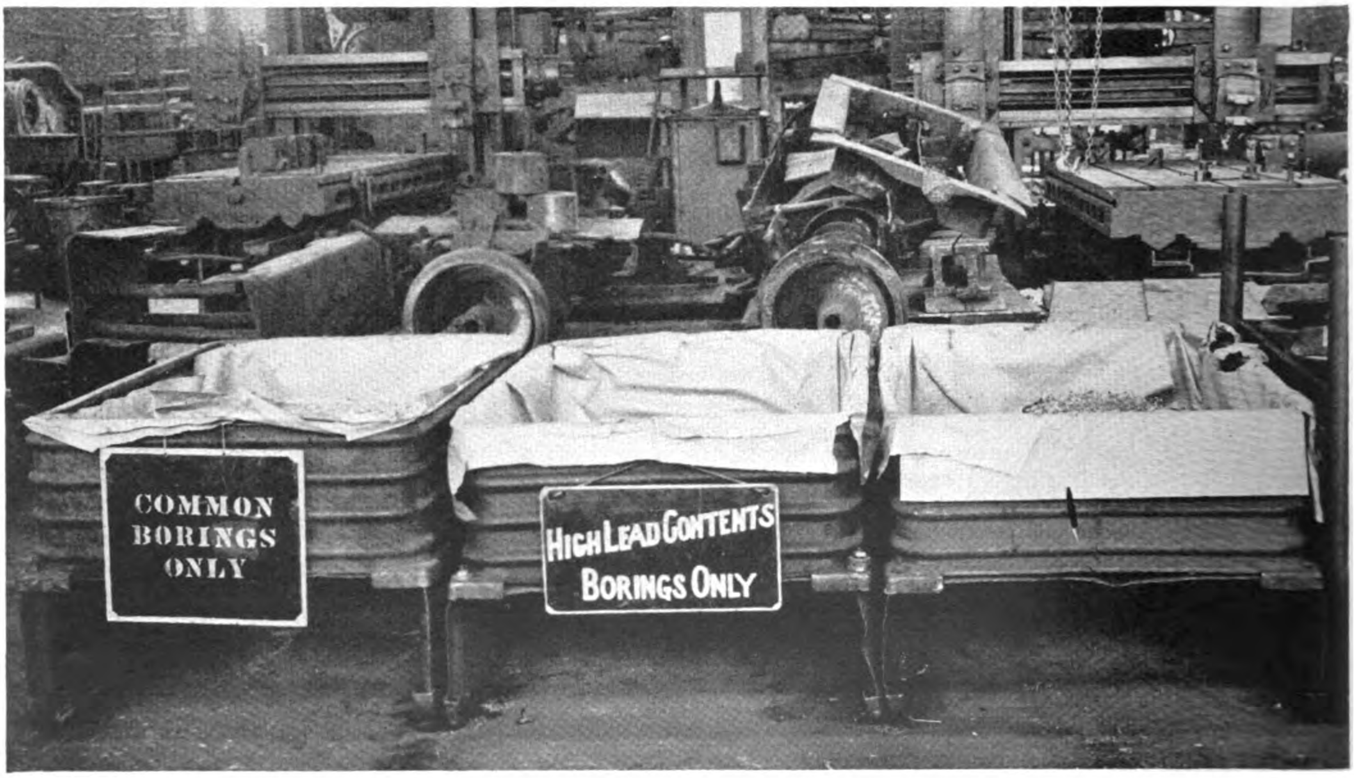
Carter took the hint and left.

* * *

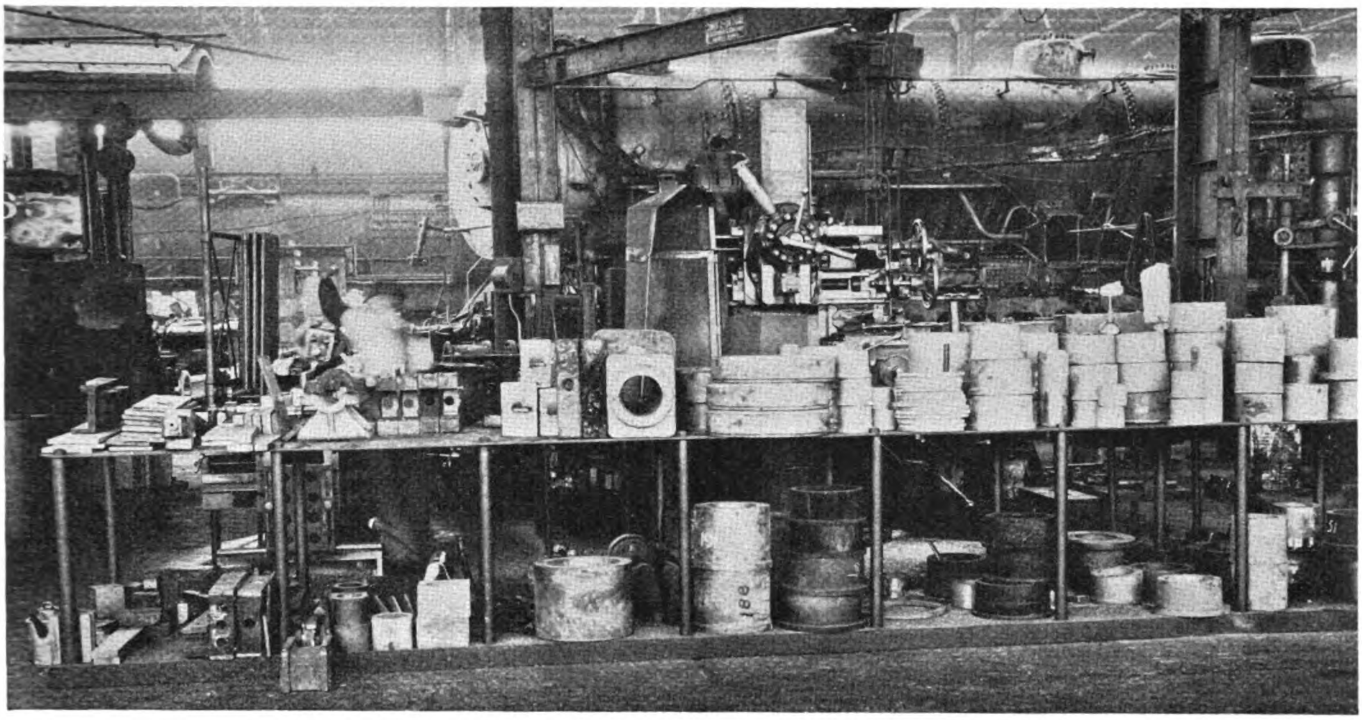
Brass Casting Rack And Chip Skids

An unusually neat arrangement, developed at the Denver, Colo., shops of the Chicago, Burlington & Quincy for the storage of brass castings, both before and after being made into rod bushings, is shown in the illustration. It consists of a special 8-section steel rack, 20 ft. long by 36 in. wide by 33 in. high, made of a heavy steel base plate and a ¼-in. steel top plate, separated by 33-in. boiler tube spacer nipples, through which one-in. bolts are applied to hold the plates together. Adequate provision is made for the heavier castings in the lower spaces and for those which are lighter and more readily handled on top of the rack. A 24-in. Bullard vertical turret lathe, used in the quick and accurate machining of these bushings, is shown in the background. Advantages of this rack include the possibility of segregating locomotive bushings by number, increased accessibility of these parts and assistance in keeping the floor orderly and clean. The Bullard turret lathe is used to meet the entire requirement of the shop for machining brass bushings of this type as well as miscellaneous other work.

In connection with this subject of machining brass castings, a special effort is made to handle brass scrap in such a way that a minimum of labor will be involved and a maximum return from the scrap realized. For example, three paper-lined lift-truck skids are assigned for the reception of different grades of brass chips. As shown in the illustration, the skid at the left is used for common brass borings; brass chips having a high lead content are stored in the center skid; and more or less unavoidable mixtures of brass and steel chips are stored in the skid at the right. In the latter case, an easy method of separation is to empty the chips on a smooth cement walk outside of the shop under the traveling crane where a heavy electro-magnet can be used to



Special paper-lined skids used in the segregation of various classes of scrap brass chips



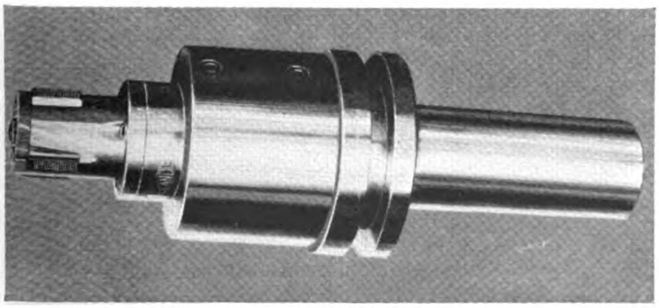
Brass bushing storage rack at Denver Shops—Bullard vertical turret lathe in the background

separate the steel chips and permit the remaining scrap brass to be returned to the skid or scrap platform and sold for a substantially higher rate than would be possible if it contained steel chips.

Yoke-Operated Collapsible Tap

A yoke-operated collapsible tap for use on automatic screw machines has been developed recently by the Landis Machine Company, Waynesboro, Pa. This tap, a modification of the Landis LT collapsible tap, is fitted with two flanges against which a forked yoke attached to the machine operates for expanding and collapsing the chasers. The chasers are collapsed by having a yoke contact the face of the flange near the front or chaser end of the tap upon completion of the desired thread length. The chasers are reset to tapping position by having the second yoke contact the flange near the shank upon the return travel of the machine spindle.

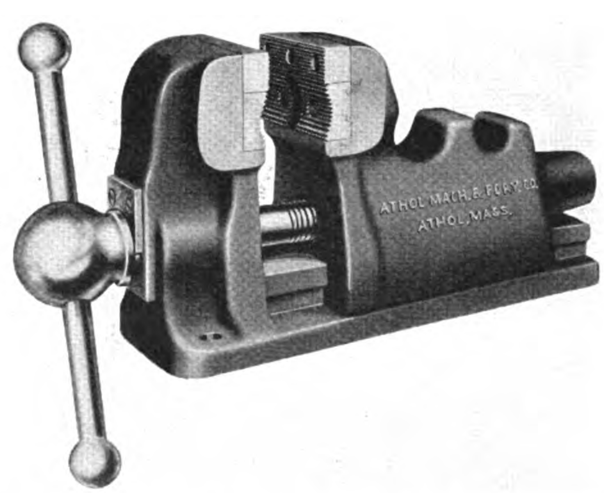
The detachable head, as used on Landis collapsible taps, whereby several sizes of heads can be applied to the same body, is used with this tap. The tap can be furnished in all sizes ranging from 1⅜ to 12 in., and can be used either as a stationary or rotary tap.



The Landis yoke-operated collapsible tap for use on automatic screw machines

Heavy Duty Steamfitters Vise

The Athol Machine & Foundry Company, Athol, Mass., has recently developed a pipe vise especially adapted to meet the requirements of heavy-duty pipe fitting in railroad shops. This model, developed in consultation with engineers of a large Eastern firm of piping contractors. The base and jaws are extra-heavy semi-steel castings, correctly proportioned to withstand the strains of steam-



Athol steamfitters' vise especially designed for heavy pipe work

fitters work. Note that the front jaw is fixed, and the back jaw moves, a feature that allows long pieces of pipe to rest upon the bench. There is no need for blocking or special supports as is the case when a movable front jaw brings the pipe out beyond the edge of the bench.

Large deeply-checked tool-steel flat-jaw facings, with straight section for ordinary work, are provided. The

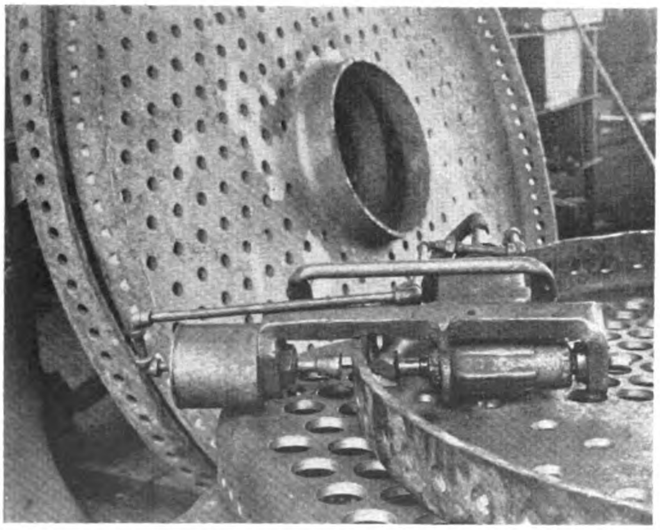
special pipe-grip sections have correctly shaped double-radius curves. Pipe of any size up to 6 in. is firmly held, as the shape of the jaw facing assures contact at several points, instead of at only one point on the pipe as with ordinary facings.

The exclusive Athol buttress thread screw is used in this new vise, and the screw is equipped with a removable nut. The buttress thread gives a full 50 per cent greater strength than a square thread of the same pitch. It is heaviest at the root, with its extra metal and extra strength just at the point where the strain is greatest. The Athol No. 1115 pipe vise handles pipe from 1/8 in. to 6 in., has jaws 5 in. wide, weighs 137 lb. and is available in the stationary-base type only.

Two Boiler Shop Tools

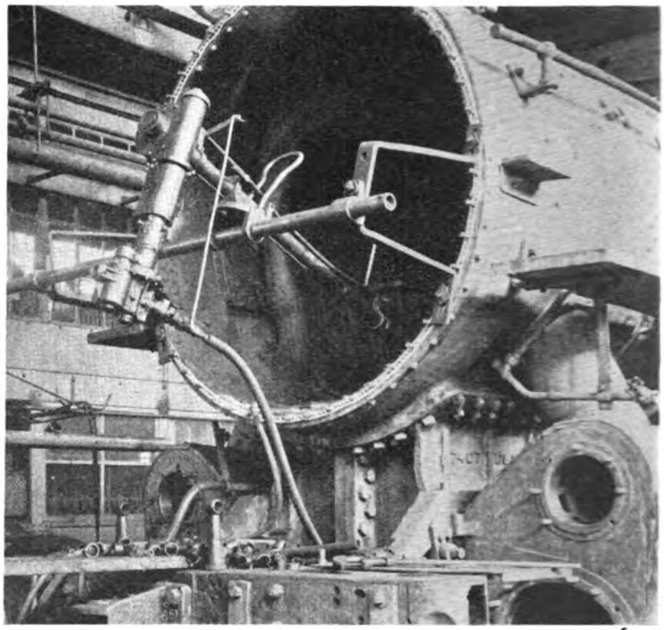
Two devices which assist greatly in connection with boiler work at the Denver, Colo., shops of the Chicago, Burlington & Quincy are shown in the illustrations. The first is a power attachment for cutting off and rolling flues in the front end. This device consists of a reversible air motor with power attachment and worm-gear drive to a 6-ft. cutter bar, this bar being mounted on a 3-in. horizontal steel tube suitably supported by brackets bolted to the boiler front ring. A gear box makes two speeds available for use, dependent upon whether large flues or small tubes are being cut. Reference to the illustration shows that the cutter bar is capable of swinging vertically or sliding horizontally on the 3-in. horizontal tube. The machine may thus be used for cutting an entire set of flues without resetting the supporting bar and brackets, as required with most other types of flue cutting machines.

The cutter bar has a telescoping bar and universal socket arrangement to accommodate various lengths, de-



Easily handled device for counterboring rivet holes in flue sheets

pendent upon the angle of cutter bar adjustment necessary for any particular tube or flue. Only one knuckle joint is necessary with this arrangement, and in view of the rigidity of the drive, very satisfactory work is performed and a longer life assured for the cutters. The safety factor is also important, as the machine is strongly made and designed so as to present little opportunity for personal injuries. The rubber hose connection to the

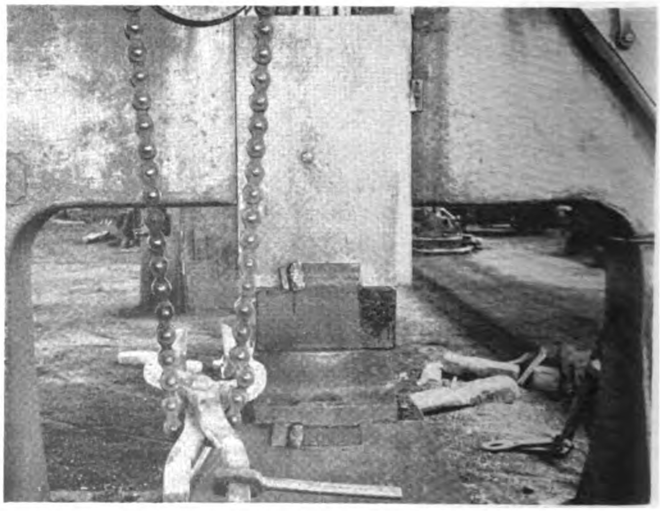


Efficient power attachment for cutting off and rolling boiler tubes and flues

air motor and conveniently accessible control levers required for one-man operation are shown in the illustration.

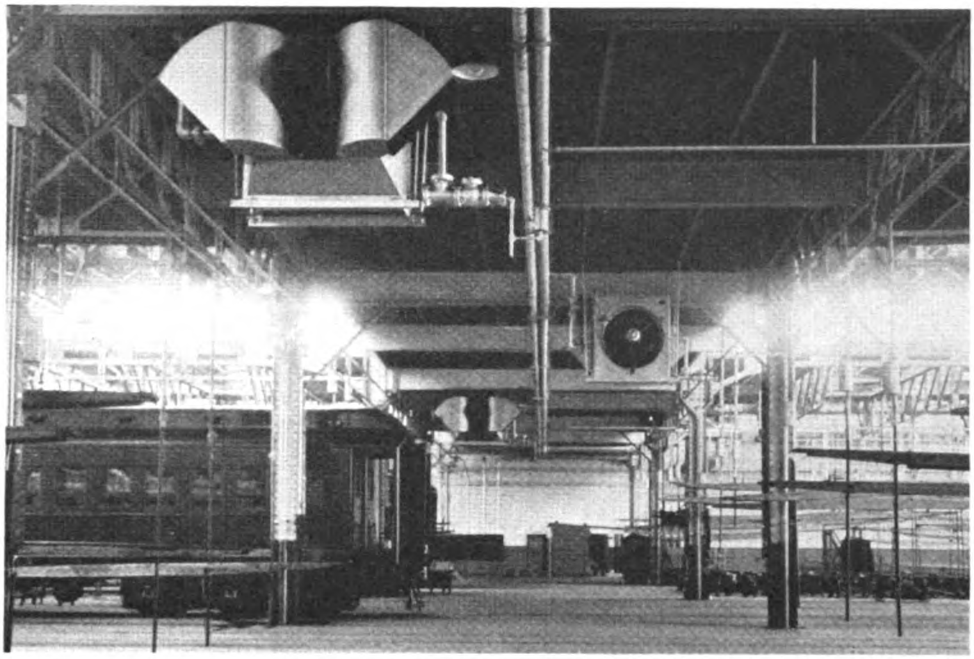
The device shown in the second illustration is an unusually compact and effective arrangement for countersinking the rivet holes in flue sheets. This consists of a steel frame to which is attached an angle motor for operating the countersink and a small cylinder and air-operated plunger which backs up the countersink and provides the necessary feed. A convenient handle is welded to the frame for greater ease in adjustment of the device and the air line to the cylinder is installed and connected so that when air is applied to operate the motor, pressure in the cylinder pulls the countersink into the rivet hole. The overall length of this device is approximately 24 in. The cylinder has a 4-in. bore and 3½-in. stroke. The air line is made of ¼-in. steel pipe and the air pressure used is that of the shop line, or about 100 lb. per sq. in.

* * *

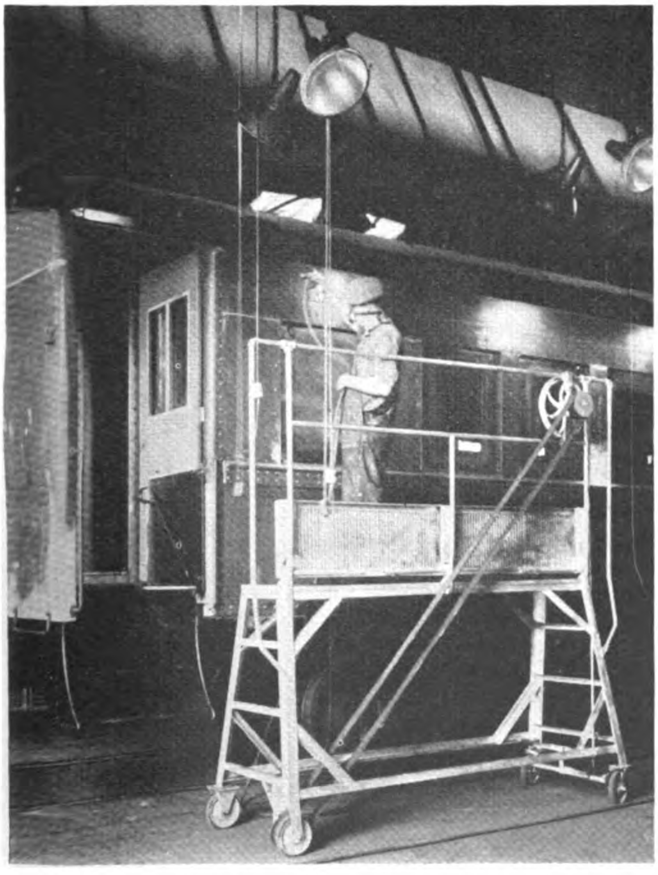


The use of a graduated scale on a steam hammer in conjunction with an adjustable pointer which may be set at zero avoids the necessity of calipering stock while being forged

With the Car Foremen and Inspectors



The paint shop showing the well-distributed daylight and the unit heaters mounted overhead



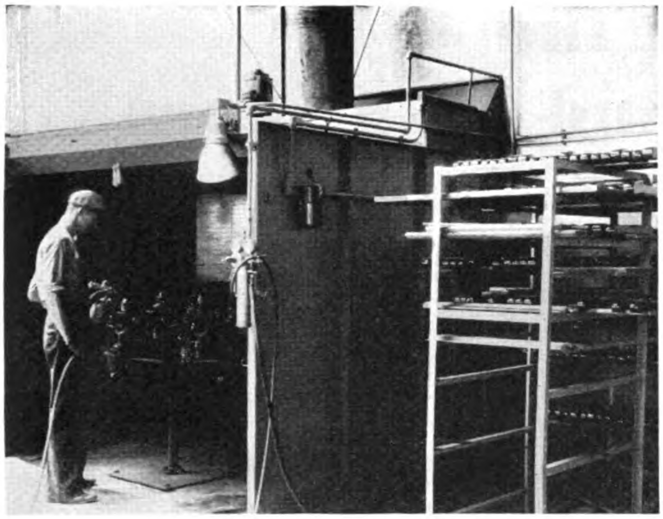
A self-propelled painting dolly which can be steered

Beech Grove Paint Shop

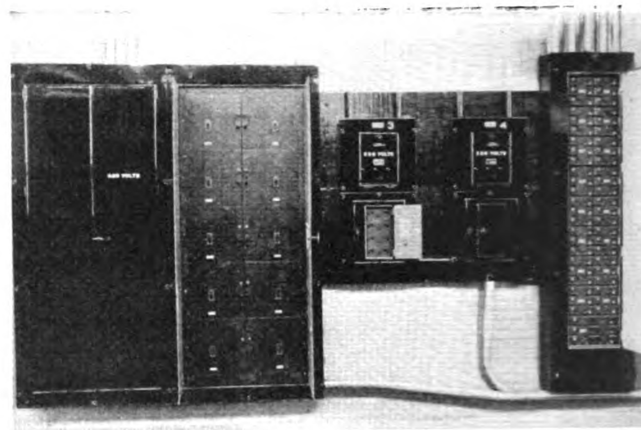
The passenger-car paint shop of the New York Central System at Beech Grove, Ind., was rebuilt in 1930, modern heating, lighting and spray-painting equipment being installed. Additional improvements have been made from time to time and the painting operations revised until this shop is now one of the best equipped passenger-car paint shops on the system.

The main building is 444 ft. long by 184 ft. wide, and houses 20 tracks, spaced on 20-ft. centers and made long enough to accommodate two cars per track. An 80-ft. by 97-ft. room is partitioned off on the west side of the shop at the north end and provided with forced ventilation and canopy exhaust hoods over Tracks 1 to 4, inclusive, which are used in all point-spraying operations on car exteriors and interiors. Tracks 5 to 17 are used in preparing cars for the spray room and trimming. Tracks 18 and 19 are scrub tracks and Track 20 is used mostly for special storage purposes.

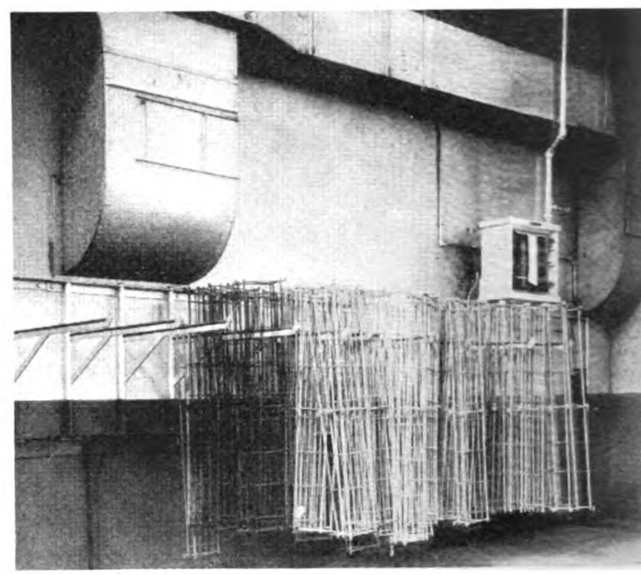
Adjacent to the car-spraying room is an 82-ft. by 80-ft. room on the east side of the shop at the north end, used in the spraying of all parts of the passenger-car trim, furniture, etc., as well as certain roadway materials. The glass room, paint storage and mixing room, office, etc., are located in a 24-ft. by 124-ft. lean-to against the side of the main shop building adjoining the varnishing room. A similar lean-to on the east side at the south end of the building provides space for lockers, toilets, the electrical foreman's office and the battery-charging room. The south end of the main shop building is partitioned off for a distance of approximately 38



One of the spray booths in the varnish room



The large switches on the right are for canopy exhaust fans and those on the left for curtain fans—Switchboards are kept locked and can be opened only by those duly authorized



Luggage racks suspended for drying on small swing cranes on the varnish-room wall.—The galvanized iron ducts conduct warm shop air under pressure to the spray room

ft. to provide for a battery-washing room and an electrical workshop. The roof of the paint shop is made as nearly fireproof as possible and thoroughly insulated with two courses of 15-lb. asphalt laid between two courses of 30-lb. felt. The partitions are fireproof and provided with sliding fire doors where necessary.

Adequate Provision for Lighting and Heating

By means of the alternate high- and low-roof construction afforded in the main paint-shop building a substantial amount of north light is available to supplement that of the large steel sash windows and excellent light is provided within the shop during daylight hours. For night painting operations adequate illumination is furnished by means of eighty-four 200-watt overhead lights, mounted in vapor-proof fixtures just below the roof trusses.

Particular attention is also paid to maintaining a temperature of not less than 65 deg. F. in the paint shop at all times. This is made possible by the well-insulated roof construction in conjunction with the provision of ample direct radiation around the doors and side walls, supplemented by eight overhead heating units located in the center aisle and used only in the severe cold weather. These heating units include six in the main shop and two in the varnish room. They are compact electric motor-driven units which take in shop air on one side and blow it through steam-heating coils and back into the shop in three directions, as shown in one of the illustrations. A 15-hp. motor-driven fan with a maximum capacity of 80,000 cu. ft. per min. furnishes warm air to the spray room to replace that removed through the exhaust stacks. This air is drawn from the upper part of the main paint shop and delivered through large rectangular galvanized-iron ducts to suitable openings in the east wall of the spray room at about an 8-ft. level.

Originally, two canopy-type exhaust hoods, each 91 ft. long, were installed over Tracks 1 and 2 in the spray room. The results with these were so satisfactory they have been supplemented by the installation of two more units of the same size over Tracks 3 and 4, so that four canopies are now available for the spray painting of cars. Each of these canopies is equipped with five 5-hp. 42 in. fan-type exhausters which may be operated individually or altogether, as needed. In addition a 7½-hp. blower fan supplies air to floor ducts and suitable slots in the floor which direct a narrow curtain of air upward past each side of the car, conveying all fumes into the overhead canopy. Distributing plates in the floor ducts assure delivery of the air at a uniform pressure throughout the length of the slots and the air velocity may be varied from 200 to 500 ft. per min., dependent upon the requirements. In order to conserve warm air in the spray room during cold weather, the exhaust stacks are provided with automatic dampers, each of which opens only when that particular stack is in operation.

Ample illumination is provided by means of thirty 300-watt lights per canopy, these lights being mounted in vapor-proof reflectors at 6-ft. intervals along the lower edges of the canopies. This intensive light, thrown directly on the car sides where it is needed, is supplemented by 200-watt overhead lights in the spray room.

When passenger cars are sent to the Beech Grove shop for overhauling they are stripped and moved to the sandblast shed where a thorough cleaning job is done, which includes the removal of all old paint, dirt, rust and scale. Just as soon as the sandblast operation is completed a priming coat is applied by the spray method. In fact, all car parts are sprayed, except the roofs. Each car then moves to the coach shop for necessary repairs, all new work and welded joints being cleaned and touched up with the primer in the coach

shop. The car is then moved outside of the coach shop, thoroughly blown out and the underneath parts sprayed. Sheet-metal shields, made to window size from second-hand car-roofing material, with 39-in. holes cut in the centers for ventilation purposes when painting the car interiors, are applied in place of the sash. After being moved into the paint shop the car exteriors are puttied and glazed where necessary and a coat of surfacer applied. Exterior surfaces are sandpapered and the two coats of the railroad company's standard finish applied. When quick-drying finishes are applied it takes a painter about 1¼ hrs. to spray each outside coat and these coats are applied one after the other with only 15 min. drying time between.

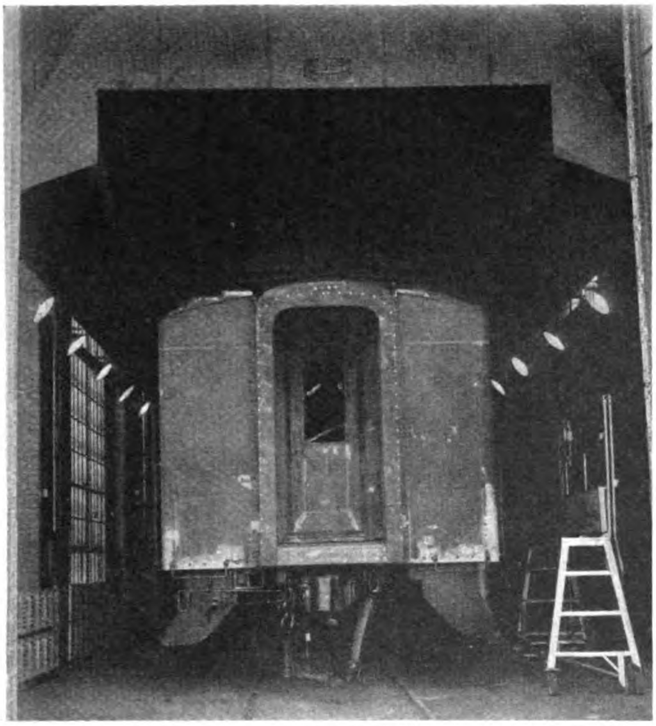
Dolly for Exterior Spraying

An unusually convenient, flexible and self-propelled painting dolly, shown in one of the illustrations, contributes to a saving of time in spraying operations. This dolly consists of a welded-steel frame constructed primarily of 2-in. and 1½-in. angles and mounted on four 6-in. steel-disc wheels with hard-rubber tires. The main dolly frame is 8½ ft. long by 2 ft. 9 in. wide at the base and has a working platform 7½ ft. long by 17 in. wide and 4 ft. 8 in. high. A supplementary hinged platform, made of steel angles and heavy wire netting, as illustrated, may be swung and locked in a horizontal position 18 in. above the main platform to give additional height when needed. The hand rail, made of ¾-in. pipe, is designed to provide a horizontal section 2 ft. 9 in. high above each platform and convenient side handholds assist in climbing onto the dolly from either end.

Referring to the illustration, it will be noted that one pair of dolly wheels is mounted on automotive type axles arranged to be swivelled and steered by means of a small rod which extends vertically upward to the upper handrail level where it is bent and bracketed to form a steering handle. At this same point on the upper handrail there is provided a brake handwheel and small pulley, connected by a belt to another pulley of the same size

Exterior exhaust pipes and weather caps which are mounted on the roof of the spray room

The Beech Grove paint shop showing a railway mail car on the car hoist



A car under one of the canopy-type exhaust hoods

riveted to the inside face of one of the fixed-axle disc wheels. By this construction the painter can readily steer and move his dolly a few feet at a time alongside the car as the painting progresses, without leaving the working platform.

The car interiors are finished the same as the exteriors up to and including the sanding. Two coats of finish are applied inside, one day being allowed between coats for drying. Each coat takes two painters about three to four hours to apply. No masking is necessary on the interior, because the spray is used down to the side-plate molding, from the side-plate molding down to the window sill, and from the sill to the floor. The window-sill and side-plate molding are cut in afterwards with a brush. When this work is done the car moves back into the paint shop for the trimming operations. The car is lettered, finish trimmed and two coats of clear penciling finish applied over the lettering. As an example eight days are required for a complete refinishing job, including sandblasting and priming.

The installation of such modern finishing facilities as are now in use at Beech Grove makes possible a wide application of such quickly applied and rapid-drying finishes as lacquers, enamels and varnishes. The procedure of refinishing a car using these various finishes follows along the same general lines as previously outlined.

In the case of cars requiring general repairs without sandblasting, the cars are brought in, scrubbed, touched up, abrasions repaired and putty applied. The cars are then sanded and the required finish applied.

Work in the Varnish Room

In the varnish room three spray booths are provided, each being equipped with a 3-hp. fan and an 18-in. exhaust pipe. Interior trim is finished in this department, including seat bases, luggage racks, sash, lighting fixtures and all other trim. Dining-car chairs and other furniture is finished here, as well as roadway materials, such as signal stands, switch lamps, etc. A revolving table is used in the spray booth and as many parts as possible laid on the table top and sprayed one at a time. Screws are dumped into a container equipped with wire screw racks so that only the heads are exposed for the spray.

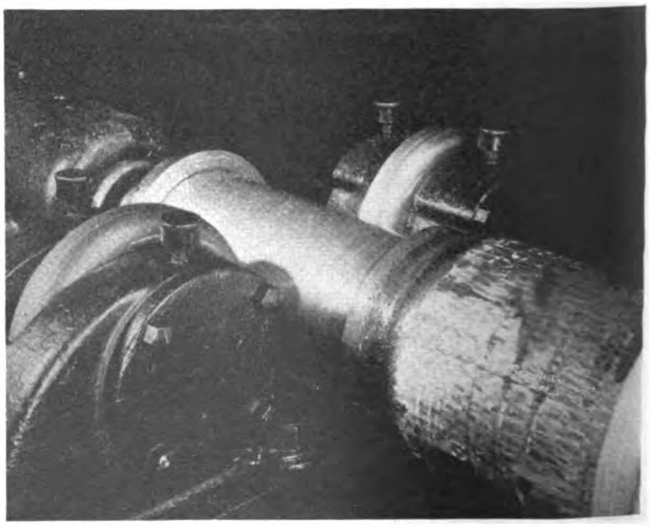
In finishing car-interior fittings luggage racks receive one primer coat and two coats of finish, then being supported for drying on convenient swing cranes, hinged to brackets on the wall of the room. Sash is sprayed with the same finish as that of the car in which it will be placed. Miscellaneous sign work is also done in the varnish room, as well as glass cutting.

Burnishing Costs Reduced With Alloy Rollers

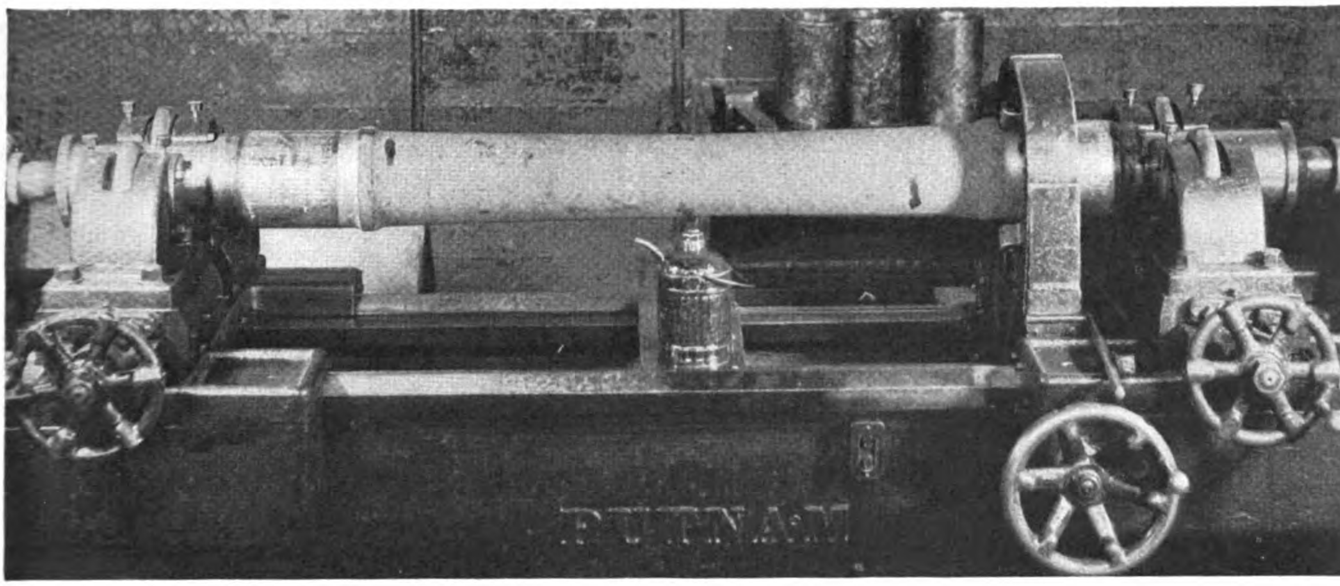
How tool modernization can increase efficiency and reduce railroad maintenance expenses is illustrated by the alloy burnishing roller for finishing driving axle journals, car axle journals and various locomotive parts. The economy resulting from the use of this roller is effected because of the better and more lasting surface produced and because car journals, crank pins, truck axles or piston rods can be rolled after being sized, thereby eliminating a finish turning operation. Only one or, at most, two rollings are necessary to produce a wearing surface. Smoothness, as shown under a low-power microscope, is attained to an extremely high degree.

A number of railroads have standardized on this type of alloy roller for rolling car-axle and locomotive driving-axle journals, engine-truck axles, crank pins, air-pump rods, piston rods and various other locomotive parts. At many shops, piston rods are rolled in a standard engine lathe with the same type of roller as is used on car axle journals. The roller is held in a tool holder and set up against the rod as tightly as is necessary and the regular feed is applied. A 4-in. piston rod, 48 in. long, rolled in this way, can be completely burnished in 15 min. At a surface speed of 150 ft. per min., and a feed of $3\frac{1}{16}$ in. per min., only one rolling is required. The alloy roller on this job has been in service for over two years.

Similar rollers at other shops have been in service for over five years, some having burnished over 21,000



Close-up of the two opposed rollers rolling the right-hand journal of a car axle on a standard car-axle burnishing machine



A car-axle burnishing machine for producing two finished journals from size-turned surfaces at a rate of one every 7 min.—These rollers have finished over 21,000 journals.

car-axle journals without requiring any maintenance whatsoever. The low overall maintenance expense is due largely to the fact that the roller is made of an alloy of cobalt, chromium and tungsten, known as Haynes Stellite. The metal is quite hard, has a low coefficient of friction, and wears slowly. In addition, it retains a fine finish which is imparted to every piece which it burnishes. The use of the roller makes it just as easy to change a lathe over for burnishing as it is to change a cutting tool.

A standard car-axle burnishing machine in service in another Eastern railroad shop makes use of four of these alloy rollers. These rollers are double opposed, two burnishing each journal of a car axle at the same time and finishing both journals in an overall time of 7 min. with the axle turning at the rate of 75 r.p.m. and a roller feed of 5½ in. per min., the two journals, each 10 in. long, can be rolled in about 2 min. In this case, in order to insure absolute perfection in the journal surfaces, each journal is rolled twice.

Questions and Answers On the AB Brake

68—*Q.—What size is the opening in timing choke 153 and what duty does it perform?* A.—$^{9}/_{64}$ in. It controls the third stage of brake cylinder pressure build-up during an emergency application.

69—*Q.—What size brake cylinder is standard with this equipment?* A.—10-in. by 12-in.

70—*Q.—With what type piston is this cylinder equipped?* A.—It is equipped with a hollow sleeve which provides for a loose push rod that is attached to the lever and rods of the brake rigging.

71—*Q.—With what kind of pressure head is the cylinder equipped?* A.—It is equipped with two kinds: one having lever brackets; one a plain head.

72—*Q.—Where is the brake-cylinder pipe connection?* A.—On the former the connection is located at the side of the lever bracket, and on the latter directly in the center of the head.

73—*Q.—What type of connections are used?* A.—Three-quarter reinforced flanged union connection.

74—*Q.—Is it necessary to open the cylinder in order to lubricate it?* A.—No. Tapped and plugged openings are provided for this purpose.

75—*Q.—Where is the lubricant applied to oil the piston sleeve and rings?* A.—Through a tapped opening in the non-pressure head.

76—*Q.—Where are the openings for lubricating piston and cylinder?* A.—Plugs are located at the pressure end of the cylinder wall, top and bottom.

77—*Q.—How are the ports leading to these openings arranged?* A.—They are so located as to deliver lubricant into a groove in the piston which is formed back of the packing cup and in front of a felt swab.

78—*Q.—What is the advantage gained through the use of a swab?* A.—The swab serves a double purpose. It prevents overflow from the groove to the non-pressure side of the piston when applying lubricant and distributes the lubricant along the cylinder walls with each application and release of the piston.

79—*Q.—What provision has been made to prevent entry of dirt?* A.—The piston rod is ground true and the non-pressure head is fitted with three metallic packing rings, designed to form a seal, and also a felt swab.

80—*Q.—As it is essential for atmospheric pressure to enter the non-pressure end during release movement, what arrangement is provided?* A.—The non-pressure head is fitted with a curled-hair strainer open to the atmosphere.

81—*Q.—Describe this arrangement.* A.—This strainer is of the cartridge type held in place by a breather cover which prevents flying dirt and water from contacting directly with the strainer.

82—*Q.—What type packing cup is used?* A.—A cup formed to fit the piston head and not cut out in the center. The cup is snapped on, over a shoulder which is machined on the piston head, no follower plate and studs or expander ring being required.

Combined Dirt Collector and Cut-Out Cock

83—*Q.—What is this device composed of?* A.—A combination of a dirt collector and cut-out cock, provided with bolting flanges for pipe connections.

84—*Q.—What are the positions of the cut-out cock handle?* A.—Vertical when open—horizontal when closed.

85—*Q.—What type of dirt collector is used?* A.—The standard check valve type, with detachable dirt chamber.

86—*Q.—What is the purpose of the umbrella shaped check valve?* A.—To hold the collected dirt in the dirt chamber under all conditions of air-brake operation.

87—*Q.—What occurs during a heavy reduction, such as during an emergency application.* A.—The check valve seats against a machined seat in the body, shutting off communication between the dirt chamber and the dirt collector outlet.

88—*Q.—What happens, in the event of dust or dirt collecting on top of the check valve?* A.—The valve is so designed and placed on the stem as to permit a rocking motion which shakes off the dust or dirt into the dirt chamber.

89—*Q.—What must be done in order to clean the dirt collector?* A.—It is only necessary to remove two nuts to drop the dirt chamber for cleaning.

Reservoirs

90—*Q.—How is the question of air storage taken care of?* A.—By means of a two-compartment reservoir, one for auxiliary and one for emergency reservoir.

91—*Q.—What is the design of this reservoir?* A.—Two designs are in use, one of welded steel construction, provided with mounting brackets at the top, and with the interior treated with the No-Ox-Id process for rust prevention, while the other reservoir is of cast metal.

92—*Q.—Is the latter made of a single casting?* A.—No. It consists of three castings, a separation plate and two flanged chambers.

93—*Q.—Are the flanged chambers identical?* A.—Yes, except that one section has a double lug, and the other compartment has only one lug.

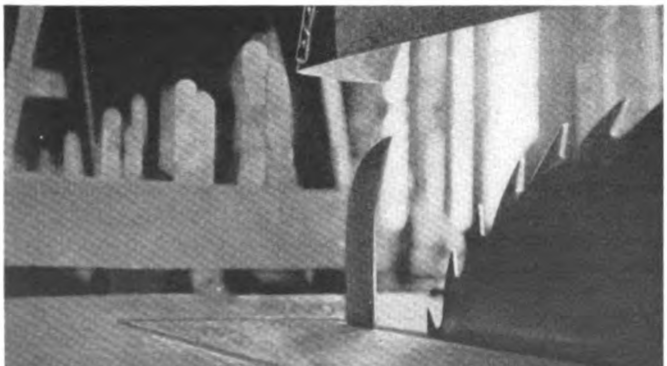
94—*Q.—What care must be taken when assembling the sections?* A.—That the separation plate is so placed that the letters "AUX" on a projecting lug on the plate are facing the auxiliary reservoir chamber, or that the lug marked "EMERG" faces the chamber which is used for the emergency reservoir.

95—*Q.—Which reservoir section has the greater volume?* A.—The emergency reservoir, due to the fact that the separation plate, (which is shaped like a wash bowl) is so placed as to have the convex face project into the auxiliary reservoir chamber.

Spreader for Sawing Thin Boards

To prevent boards or other thin lumber from closing-up after it passes through the rip saw the planing mill foreman on one railroad devised a spreader which is secured to the saw table directly in back of the saw and which follows through the saw grove, spreading the lumber sufficiently to prevent its closing up and binding.

The spreader is made from tool steel and is ground to a knife edge at the front to a thickness of $\frac{1}{16}$-in. larger than the saw thickness. This device will eliminate many accidents in the mill and will permit one man to handle many jobs that ordinarily require two men to handle, especially on thin material.

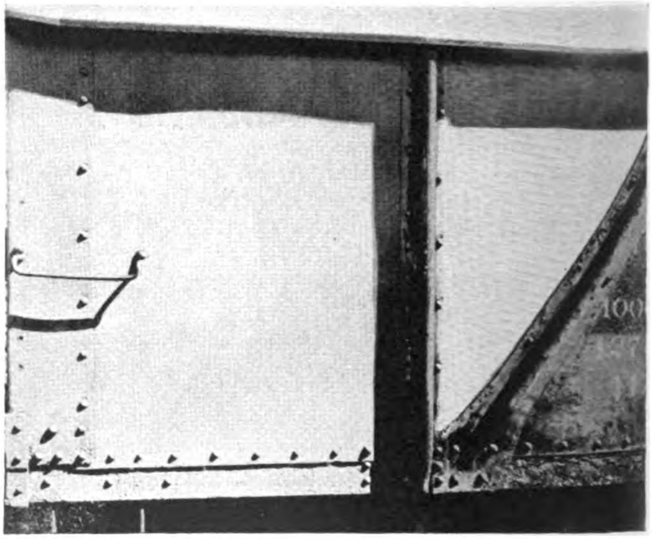


The spreader follows the saw in the groove

Preservative Coating for Wood, Metal and Other Surfaces

Pure metallic copper of extreme fineness and of the irregular flaky structure known as "dendritic" can now be applied to iron, steel, wood, concrete, or other surfaces which require a protective coating. This new coating is being produced by the American Coppercote, Inc., 480 Lexington Avenue, New York, N. Y., under the name Coppercote.

All types of corrosion problems were taken into account in the development of Coppercote which involved the production of a special vehicle in which the minute flakes of pure metallic copper remain in perfect suspension. While the coating is being applied, a physico-chemical reaction occurs between the particles of copper and its vehicle. Since the copper is dendritic in structure rather than granular, a closely knit coating results which, when set, forms a tough hard metallic surface. When applied to a surface of ferrous metal it is claimed that corrosion will be prevented completely, and when applied to a surface already rusted, it will arrest any further corrosive action. It is said that the



Coppercote applied to the panels of a badly rusted gondola car. The heavy scale on two end panels was chipped off and the corrosion burned onto the plates with a blow torch.—This shows the condition of the Coppercote after 15 months exposure.—There is no indication of rust breaking through the surface

Coppercote will not crack, scale nor chip as a result of extremes of temperature nor is it affected by the ultra-violet rays of the sun.

A turbulent action which takes place when Coppercote is applied causes it to spread itself automatically and to work its way into every pore of the coated surface to which it becomes thoroughly united. The result is a sealed metallic surface said to be permanently impenetrable by either air or moisture and therefore a positive protection against corrosion. This action throws off every air bubble and closes every pin hole, but more important than this, there occurs a definite stratification of the metallic copper and its vehicle. The copper particles combine and adhere closely to the base while the vehicle rises and forms a second protective film. The phenomenon permits the use of various colors in the vehicle.

Coppercote has been demonstrated to be a non-conductor of electricity. Due to the insulative character of the coating, destructive electrolytic action is impossible.

Many severe tests covering a period of several years have demonstrated that Coppercote is an effective preservative coating suitable for a variety of surfaces and conditions. Coppercote has resisted corrosion on steel columns under conditions of extreme dampness; on deeply corroded specimens of angle iron buried in coal cinders for one year; on steel specimens buried in alkaline soil for two years, and on steel panels immersed in gasoline for extended periods. In another instance a heavy steel test specimen was treated with Coppercote and attached to a pier in Long Island Sound in such a position that at low tide the specimen was exposed to the elements and to the sun while at high tide it was completely submerged. This test was carried on for a number of months and at its conclusion it is reported that the specimen was found to be in perfect condition.

It has been demonstrated that the application of Coppercote to wooden structures provides effective protection against the termite and also against marine borers including the teredo and limnoria. Extensive tests on wooden panels conducted in waters where marine borers are prevalent revealed that the panels after submersion for many months were completely protected.

In addition to its corrosive proofing qualities, Coppercote is fire resistant and its application to wooden structures will reduce fire hazards. Also, concrete floors, brick walls and similar surfaces can be waterproofed by treatment with Coppercote.

Improved Spray Fluid Nozzles And Atomizer Heads

The Paint Spray Equipment Division of the Alexander Milburn Company, 1493 W. Baltimore St., Baltimore, Md., announce major improvements in atomizer heads and fluid nozzles for their paint spray guns. The fluid nozzle is of an improved design and incorporates features which make it a more efficient and economical unit for spraying various materials. It is made of a high grade, wear-resisting steel and has a long tapered seat which is accurately machined and burnished for perfect alignment with the atomizer head. The air passages are closely spaced and provide a large annular air supply to the atomizer head for increasing the effectiveness of the atomized spray. The internal tapered seat is finished to exacting specifications allowing the paint needle point to seat accurately and prevent dripping or spattering. One particular feature is that the nozzle is machined to seat on the base of the thread of the head, keeping paint or other material out of the threads and thereby eliminating clogging.

The bronze atomizer head is of one-piece design and is made with straight air passages, eliminating friction and rendering it easy to clean. Air requirements are provided by large nonfrictional air passages and expansion chambers which increase the velocity and volume for producing atomization at lower pressures.

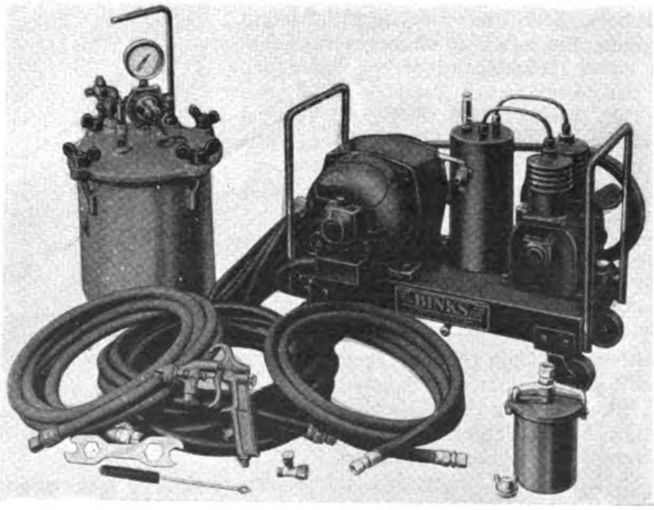
These fluid nozzles and atomizer heads are manufactured for siphon or force feed and in sizes and styles to handle any type of material from the finest lacquer to the heaviest synthetic enamel.

Portable Paint Sprayer

Development of a rubber-tired portable paint-spraying unit has been announced by the Binks Manufacturing Company, 3114 Carroll Avenue, Chicago, Ill. Mounted on a wheeled base, the unit consists of a ½-hp. electric motor, an air-compressor unit, a pressure tank with a capacity of 2 gal., a standard Binks bleeder-type spray gun with adjustable nozzle, and various lengths of rubber hose. A ½-hp. gasoline motor may be used where electricity is not available. Complete, the outfit weighs 180 lb. The spray gun furnished with the unit is a Binks Thor model 6B gun, recommended for touch-up and fine-finish work. An alternate spray gun with a flat nozzle or round and angle sprays can be used for maintenance work.

The compressor is a two-cylinder air-cooled unit, with a bore of 2¼ in. and a stroke of 1¾ in. It has a working pressure of 45 lb. and is driven by a V-belt from the electric motor. The air chamber is equipped with a drain cock and safety valve set at 60 lb. pressure. The chamber also serves as an oil and water extractor.

The pressure tank is equipped with one air-pressure regulator and gage, and a safety valve set for 60 lb. pressure. Three lengths and types of hose are provided, including a 25 ft. length of air hose from the compressor to the tank, a 12 ft. length of ½-in. air hose from the tank to the gun, and a similar length of ⅜-in. hose and connections to go from the tank to the gun.



Binks portable paint-spraying unit for touch-up and fine-finish work

Among the Clubs and Associations

Toronto Railway Club.—W. A. Newman, mechanical engineer of the Canadian Pacific, will discuss The Railway Equipment of the Future at the November 23 meeting of the Toronto Railway Club to be held at 7:45 p.m. at the Royal York Hotel, Toronto.

New York Railroad Club.—The New York Railroad Club will hold its annual dinner on Thursday evening, December 10, at the Commodore Hotel, New York. Herbert W. Wolff, senior vice-president of the American Car & Foundry Company, is general chairman of the General Committee in charge of the affair.

Southern and Southwestern Railway Club.—Electric Welding will be the subject of a paper to be presented by A. M. Candy, consulting engineer of the Hollup Corporation, before the meeting of the Southern and Southwestern Railway Club to be held at 10 a.m. on November 19 at the Ansley Hotel, Atlanta, Ga.

Car Foremen's Association of Chicago.—The annual meeting of the Car Foremen's Association of Chicago, held Friday, October 16, at the LaSalle Hotel, was devoted primarily to an evening of entertainment under the direction of R. M. McKisson, American Steel Foundries, chairman of the social committee, about 500 members and guests of the association being present to enjoy the festivities. At a brief preliminary business meeting presided over by President C. O. Young, Illinois Central, credit for the unusually favorable condition of the association both as regards membership and finance was given to President Young and to the good work of an active booster committee headed by K. A. Milar, Milar & Company, Chicago. ¶ At the close of the business meeting, the following officers were elected to direct the activities of the association in the coming year: President, J. S. Acworth, supervisor of equipment, General American Tank Car Corporation; first vice-president, F. A. Shoulty, general car foreman, Chicago, Milwaukee, St. Paul & Pacific; second vice-president, P. B. Rogers, car shop superintendent, Atchison, Topeka & Santa Fe; treasurer, C. J. Nelson, superintendent, The Chicago Car Interchange Bureau; secretary, George K. Oliver, assistant passenger car foreman, Baltimore & Ohio Chicago Terminal. The board of directors includes W. Snell, C. M. St. P. & P.; F. L. Kartheiser, C. B. & Q.; A. W. Berger, C. & N. W.; J. C. Shreeve, E. J. & E.; C. W. Broo, N. Y. C. & St. L.; G. C. Christy, I. C.; J. S. Acworth, General American Tank Car Corporation; F. R. Callahan, Pullman Company; R. R. Hawk, Wilson Car Lines; A. E. Smith, Union Tank Car Corporation; K. A. Milar, Milar & Company, and W. J. Demmert, Griffin Wheel Company.

A.S.M.E. Annual Meeting

A minimum of simultaneous technical sessions have been arranged for this year's annual meeting of the American Society of Mechanical Engineers to be held at the Engineering Societies building, New York, November 30 to December 4, inclusive. Recourse is being had to two evening sessions, Monday, November 30, and Thursday, December 3, and to an increased number of gatherings, some combined with luncheons, at which the panel method will permit discussion of present trends and topics of interest in general and special fields. Among the discussions planned, to be conducted by the panel method, will be one Wednesday afternoon, December 2, in honor of George Westinghouse, at which former associates will discuss his engineering achievements. The annual dinner will be held on Wednesday evening, December 2.

The program in part is as follows:

Tuesday, December 1
2 p.m.
Railroads

The Use of Alloy Steels for Side Frame and Bolsters of Freight-Car Trucks, by D. S. Barrows
Report on Railroad Aerodynamics Subcommittee of Aeronautic Division (to be presented by title)
Progress Report of Railroad Mechanical Engineering

4:30 p.m.
Westinghouse Ninetieth Anniversary

8 p.m.
Honors Night
Towne Lecture, by Dr. James Rowland Angell, president of Yale University

Wednesday, December 2
9:30 a.m.
Cutting Metals

Cemented Carbide Tool Maintenance and Application, by L. J. St. Clair

2 p.m.
Machinery and Springs

Discussions of Spring Problems To Include Rubber Springs, Helical Springs and Spring Materials
Bearing Oil-Ring Performance, by R. Baudry and L. M. Tichvinsky
Quieting Machinery, with demonstrations by E. J. Abbott

6:30 p.m.
Annual dinner and Thurston lecture, Astor Hotel

Thursday, December 3
9:30 a.m.

Management
(Jointly with Society for Advancement of Management and Personnel Research Federation)

Dealing with Workers Today
Modern Principles and Practice of Manufacturing Organizations in Employee-Employer Relationship, by W. G. Marshall, T. I. Phillips, J. H. Priest, and R. M. Rumbel—Representatives of the Westinghouse Electric & Manufacturing Company

Corrosion-Resisting Metals—
Symposium I

Introduction to Corrosion Resistant Metals, by F. H. Speller
Aluminum and Its Alloys, by E. H. Dix, Jr., and R. B. Mears.
Construction and Use of Lead Equipment, by G. O. Hiers

2 p.m.
Corrosion-Resisting Metals—
Symposium II

Zinc in the Chemical Industries, by E. A. Anderson
Cast Iron, by Dr. H. L. Maxwell
Copper and Copper-base Alloys, by R. A. Wilkins

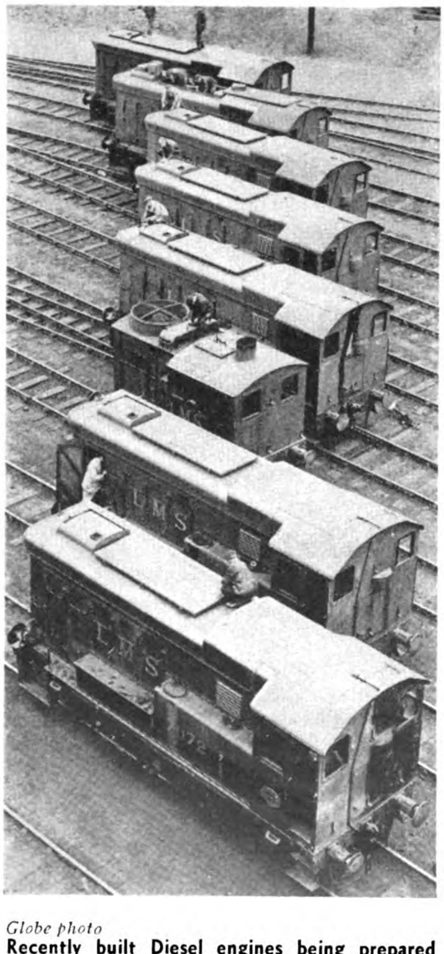
Management

Training to be Skilled Workers
Symposium sponsored by Management Division, Committee on Education and Training, Society for Advancement of Management and Personnel Research Federation
F. E. Seale, superintendent, Ford Motor Car Company schools, will discuss the selection of apprentices and their training to operate machines
Chas. G. Simpson, Philadelphia Gas Works, will discuss adult education

8 p.m.
Corrosion-Resisting Metals—
Symposium III

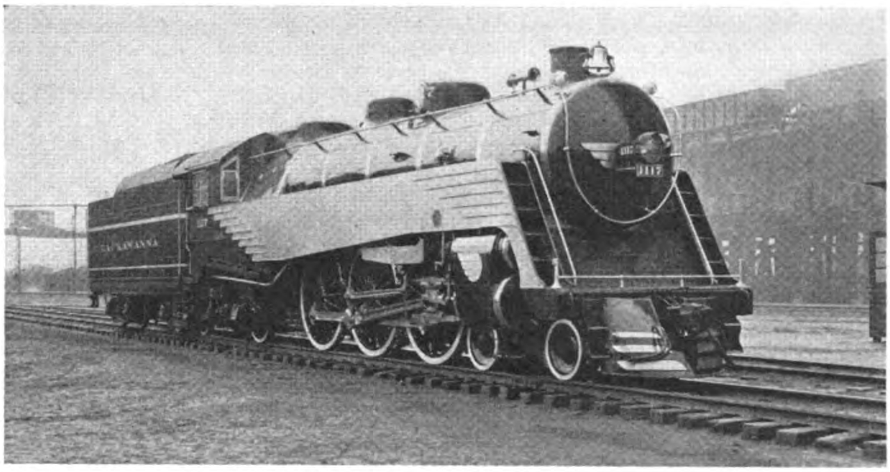
Corrosion-Resistant Steel, by J. H. Crickett
Nickel and Nickel-Base Alloys, by F. L. LaQue

* * *



Globe photo

Recently built Diesel engines being prepared at the Crewe (England) works of the London, Midland & Scottish Railway for a day's work



A Delaware, Lackawanna & Western Pacific type passenger locomotive remodeled at that road's Scranton (Pa.) shops to effect a semi-streamline exterior—The finish is in black with chromium striping, trim and skirting below the running boards and silver-leaf lettering and striping on the tender

NEWS

Link Motion Valve Gear — A Correction

THE first equation in the formula appearing with Fig. 2 at the top of page 392 of the September issue of the *Railway Mechanical Engineer* is incorrect. It should be

$$V_h : V_e = V_k : S_o$$

Clinchfield Rail Lubricator— A Correction

ON page 397 of the September issue of the *Railway Mechanical Engineer* the oil-consumption cost per mile of curves per month is given as $.094. This should be $.94.

Power Reverse Gear Agreement Approved by A.A.R.

AN agreement reached between committees representing the carriers and the locomotive brotherhoods governing the installation of power reverse gears on locomotives was approved by member roads of the Association of American Railroads at a special meeting at the Blackstone hotel, Chicago, on September 25. Under the agreement all locomotives built after September 1, 1936, are to be equipped with power reverse gears, while all locomotives used in road service and weighing 150,000 lb. or over on drivers, and all switching locomotives weighing 130,000 lb. or over on drivers, are to be similarly equipped when they are placed in the shops for major repairs; this not later than January 1, 1942, unless the management and representatives of the employees on individual roads agree otherwise.

Negotiations on behalf of the railroads were conducted by Ralph Budd, president of the Chicago, Burlington & Quincy; M. W. Clement, president of the Pennsylvania; L. A. Downs, president of the Illinois Central; J. B. Hill, president of the Louisville & Nashville; F. W. Sargent, president of the Chicago & North Western; F. E. Williamson, president of the New York Central, and J. J. Pelley, president of the association.

The question of installing power reverse gears in locomotives has been under consideration for several years. On January 18, 1933, the Interstate Commerce Commission, after hearings, issued an order directing the railroads to equip their locomotives with power reverse gears before January 1, 1937. The order of the commission was entered on a complaint of the Brotherhood of Locomotive Engineers and the Brotherhood of Locomotive Firemen and Enginemen, which alleged that manually operated reverse gears are inherently unsafe and unsuitable in principle and design, subjecting the traveling public to unnecessary peril and violating the boiler inspection act. In June, 1933, the American Railway Association and the American Short Line Railroad Association asked the federal district court for the Northern district of Ohio to set aside the commission's order, and on November 24 of that year the order was annulled by three federal judges in court at Cleveland. On January 7, 1935, the Supreme Court of the United States affirmed the decree of the lower court, basing its decision on the ground that the commission could make an order of the kind only in the interests of safety, and that there was an absence of any real finding that safe operation requires the discontinuance of the manual reverse gear and the substitution of the power reverse gear. Upon the request of the Brotherhood of Locomotive Engineers, the commission reopened the case on October 29, 1935, and briefs were filed in July, 1936. Since the commission has not rendered its decision, this agreement is expected to result in the dismissal of the proceedings.

Missouri Pacific Rebuilding Enginehouse

THE Missouri Pacific has awarded a contract for rebuilding its enginehouse at Osawatomie, Kan., which was recently largely destroyed by fire, to the S. Patti Construction Company, Kansas City, Mo. As in the case of the old structure, the new enginehouse will consist of eighteen 110 ft. and 120 ft. stalls.

R. F. & P. Plans Additions to Acca Terminal

THE Richmond, Fredericksburg & Potomac has authorized additions to its Acca locomotive terminal at Richmond, Va. The plans call for a machine and repair shop and new storehouse building with the necessary tracks; removal and reconstruction of the boiler shop and the removal and relocation of machine tools, etc. The work, being carried out by company forces, will cost about $135,000.

Heavy Train Demonstration on Union Railroad

PRESIDENT R. T. Rossell of the Union Railroad Company, together with President George H. Houston and Vice-President Robert S. Binkerd of the Baldwin Locomotive Works, were hosts to a large party of railroad executives assembled in Pittsburgh, Friday, October 9, to witness a demonstration of the powerful switching and transfer locomotives which were built by the Baldwin Locomotive Works for the Union Railroad and which have been in service since last spring. The locomotives, with an 8,000-ton train, were operated over a ruling grade of 1.39, which is more than two and a half miles long.

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These locomotives, which are of the 0-10-2 type, have 61-in. driving wheels, 28-in. by 32-in. cylinders, and a total weight for the engine of 404,360 lb., with 343,930 lb. on the driving wheels. They exert a tractive force of 90,900 lb. and are equipped with reversible boosters, driving on the front tender truck, which develop a tractive force of about 17,000 lb. at starting.

Equipment Improvement Programs

THE Baltimore & Ohio has started work on locomotive repairs in four of its principal shops. The reconditioning and repair of 100 freight locomotives are included in the program. To perform the specialized work of locomotive rehabilitation requires the return of 250 employees at Baltimore, (Mt. Clare), Md., 150 at Cumberland, 150 at Glenwood, Pa., and 175 at DuBois, a total of 725 employees. Work will also start shortly on the rebuilding of 1,000 box cars, in the car shops at Cumberland, Md., Keyser, W. Va., DuBois, Pa., Chillicothe, O., and Washington, Ind. The work will require the re-employment of 550 carmen. When completed, the cars will be of the all-steel type, with the covered-wagon top which the B. & O. developed last year.

Denver Zephyr Averages 83.3 M.P.H. on Record Run

A NEW world's record for railway speeds was established by the Chicago, Burlington & Quincy on October 23, when part of the equipment of one of its new Denver Zephyrs—six body units on ten trucks and a two-unit locomotive—covered the 1,017.22 miles from Chicago to Denver in 12 hr. 12 min. 27 sec., an average speed for the entire distance of 83.33 m.p.h. This train, which had come from the builders only a few days before, left the Union station, Chicago, at 7 a.m. (Central Time) and arrived at the Union station in Denver, Colo., at 6:12:27 p.m. (Mountain Time).

On this run, which was made without a stop, a maximum speed of 116 m.p.h. was attained near Brush, Colo., while 26.6 consecutive miles were covered at an average speed of 105.8 m.p.h. in Illinois. The fastest between-station average, 107.30 m.p.h. for 6.11 miles, was made during this stretch. The train traveled from Lincoln, Nebr., to Denver, a distance of 482.66 miles, with a net rise in altitude of 4,035 ft., in 326 min. 32 sec., an average speed for this distance of 88.69 m.p.h.

In addition to the stretch of 26.6 miles at over 100 m.p.h. mentioned above, the Denver Zephyr also operated at speeds above 100 m.p.h. between stations for the distances and speeds shown below:

Miles	Av. m.p.h.
3.14	102.76
15.74	102.75
4.34	104.16
4.69	103.58
6.56	101.36
7.39	100.39
13.73	100.48
11.17	104.18

Since this run bettered the records established by the original Zephyr—a three-unit articulated train—on May 26, 1934, when it ran from Denver to Chicago in 13 hr. 5 min. (at an average speed of 77.5 m.p.h.), comparisons between the two runs are interesting. Since the route of the original Zephyr was into the Century of Progress exhibition grounds in Chicago, instead of into the Union station there, its mileage was 1,015 miles, or two miles less than the record run on October 23. The following table gives a comparative log of the two record runs:

	Distance Miles	Time: Min.	Time: Sec.	Time: Av. m.p.h.
ORIGINAL ZEPHYR				
Halsted St.-Aurora ...	35.8	28	18	75.8
Aurora-Galesburg	124.4	86	0	86.7
Galesburg-Ottumwa ...	117.4	92	25	76.3
Ottumwa-Creston	113.3	91	23	74.4
Creston-Pacific Jct. ..	82.1	60	52	80.9
Pacific Jct.-Lincoln ...	59.6	58	22	61.2
Lincoln-Hastings	96.3	74	47	77.2
Hastings-McCook	132.0	97	41	81.1
McCook-Akron	142.9	97	45	87.7
Akron-Denver	111.4	97	25	68.6
DENVER ZEPHYR				
Halsted St.-Aurora ..	35.8	30	5	71.4
Aurora-Galesburg	124.4	81	25	91.6
Galesburg-Ottumwa ...	117.4	85	25	82.4
Ottumwa-Creston	113.3	88	32	76.7
Creston-Pacific Jct.	82.1	56	48	86.7
Pacific Jct.-Lincoln	59.6	59	5	60.5
Lincoln-Hastings	96.3	71	5	81.3
Hastings-McCook	132.0	97	31	81.2
McCook-Akron	142.9	94	9	91.1
Akron-Denver	111.4	74	47	89.3

As on the original run, the Denver Zephyr operated over the freight cut-off from Pacific Junction, Iowa, to Lincoln, Nebr., thus avoiding the Omaha terminals.

New Equipment

LOCOMOTIVE ORDERS

Road	No. of locos.	Type of loco.	Builder
Atchison, Topeka & Santa Fe........	1	4-6-4	Baldwin Loco. Wks.
	1	4-8-4	
Birmingham & Southern.............	5	900-hp. Diesel-elec.	Electro-Motive Corp.
Boston & Maine....................	5 [1]	4-8-2	Baldwin Loco. Wks.
	5 [1]	4-6-2	Lima Loco. Wks.
Detroit & Toledo Shore Line........	3	2-8-2	Lima Loco. Wks.
Kansas City	10	2-10-4	Lima Loco. Wks.
Universal Atlas Cement Co..........	1	600 hp. Diesel-elec. switcher	American Loco. Co.

LOCOMOTIVE INQUIRIES

Road	No. of locos.	Type of loco.	Builder
Chicago, Milwaukee, St. Paul & Pacific	30 [2]	4-8-4 freight	....
	1	Hiawatha type	....
	7	Boosters	....
Denver & Rio Grande Western......	5	4-8-4	....
	10	4-6-6-4	....
New York Central System...........	25	4-6-4	....
	25 [3]	0-8-0	....
Union Pacific	20	4-8-4	....
Western Pacific	4	2-8-8-2	....
	7	4-6-6-4	....
Wheeling & Lake Erie..............	10	2-8-4	....

FREIGHT CAR ORDERS

Road	No. of cars	Type of car	Builder
Bethlehem Steel Co.................	100	70-ton hopper	Company shops
Chicago & Eastern Illinois...........	500	50-ton box	Gen. American Trans. Corp.
Cincinnati, New Orleans & Texas Pacific	10	Koppel air-dump	Pressed Steel Car Co.
Kansas City Southern..............	500	Box	Pullman-Std. Car Mfg. Co.
	300	Box	Gen. American Trans. Corp.
	100	Gondolas	Mt. Vernon Car Mfg. Co.
Kennecott Copper Corp.............	250	100-ton ore	Pressed Steel Car Co.
Reading Co.	200	Gondolas	Company shops
	200	Auto.-box	Company shops
St. Louis Southwestern.............	50	Steel underframes for flat cars	American Car & Fdry. Co.
Wabash	400 [4]	55-ton hopper	Wabash Car & Equip. Co.[5]

FREIGHT CAR INQUIRIES

Road	No. of cars	Type of car	Builder
Chicago, Rock Island & Pacific.......	350	Auto-box with Evans loaders	....
Donora Southern	20	70-ton air dump	....
Gulf, Mobile & Northern...........	100	Gondola	....
	150	S. S. box	....
	400 [6]	50-ton box	....
Texas Co.	4	10,000-gal. tank	....
Western Pacific	100	50-ton ballast	....
	50	50-ton flat	....

PASSENGER CAR ORDERS

Road	No. of cars	Type of car	Builder
Kansas City Southern..............	4 [7]	Coaches	Pullman Std. Car Mfg. Co.
	1 [7]	Comb. dining and chair car	

PASSENGER CAR INQUIRIES

Road	No. of cars	Type of car	Builder
Chesapeake & Ohio.................	3	Comb. pass & bagg.	....
Chicago, Rock Island & Pacific......	6 trains[8]	....	....
Seaboard Air Line.................	6	Trailer	....

[1] The five mountain type locomotives will each cost about $125,000. While they are primarily intended for use in freight service, they will be so fast that they can be used for speedy passenger service with long trains. They will be 105 ft. long and weigh over 396 tons each. The tenders will have a capacity for 20,000 gallons of water and 21 tons of coal. The 5 locomotives of the Pacific type will be built for speeds as high as 90 m.p.h. They will be used on fast trains such as The Minute Man, The Pine Tree Limited, The Kennebec Limited, The Cannonball and The Gull. These locomotives will cost about $100,000 each. They will have driving wheels 80 in. in diameter and the tenders are to be equipped with an auxiliary or booster engine used as an aid to smooth starting of long and heavy trains. Delivery of the new passenger locomotives is expected in December and the freight locomotives will be delivered the first part of the year and will go into service as fast as they arrive. Both the freight and passnger locomotives will be equipped with an automatic device which records on a tape the speed at which the engine is operated all the time it is moving. They will also be equipped with mechanical stokers.

[2] The freight locomotives, which will have a traction effort of 70,000 lb., will necessitate an expenditure of $650,000 for the replacement of turntables, the enlargement of enginehouse stalls and the strengthening of bridges in the territory where they are to operate. The passenger locomotive will be the same type as the three now in service on the Hiawatha.

[3] For service on the Pittsburgh & Lake Erie.

[4] Authorized by the federal district court.

[5] A subsidiary of the Wabash.

[6] Alternate bid.

[7] To be air conditioned.

[8] The Rock Island, subject to the approval of the federal district court and the Interstate Commerce Commission, will purchase six light-weight streamlined trains at a cost of approximately $2,500,000. Alternative bids have been asked on aluminum and stainless steel and Diesel-electric and steam motive power for three and four car trains.

Supply Trade Notes

THE NATIONAL CARBIDE SALES CORPORATION, New York, subsidiary of the Air Reduction Company, has changed its name to the National Carbide Corporation.

THE LINDE AIR PRODUCTS COMPANY, New York, a unit of the Union Carbide & Carbon Corporation, has opened a new district office at 2 Virginia street, Charleston, W. Va., with A. R. O'Neal as district manager.

THE GOULD COUPLER CORPORATION, Depew, N. Y., has succeeded to and acquired the entire business of The Gould Coupler Company. No change is contemplated in policies, management or business operations.

W. C. STRAUB, manager of the New York Branch office of the Chicago Pneumatic Tool Company, New York, has been appointed assistant to the executive vice-president, and has been succeeded by A. D. Stem.

THE HAMMOND MACHINERY BUILDERS, INC., Kalamazoo, Mich., has established a new eastern branch office and sales room at 148 East Twenty-third street, New York. The office is in charge of W. J. Holtmeier, eastern manager.

W. L. KEADY, vice-president in charge of operations of the United States Gypsum Company, has been appointed vice-president in charge of sales, and L. H. Atkinson, assistant to the vice-president, has been appointed general sales manager.

B. C. TUCKER, who has been appointed sales representative of the Union Railway Equipment Company at Cleveland, as reported in the August issue of the *Railway Mechanical Engineer*, page 372, also continues as president of the Midland Railway Supply Company.

GEORGE H. BUCHER, vice-president of the Westinghouse Electric & Manufacturing Company, has been elected executive vice-president of the company. Mr. Bucher, who is also president and general manager of the Westinghouse Electric International Company, will have his headquarters at Pittsburgh, Pa.

LESTER A. CRONE, vice-president of the Buffalo Brake Beam Company, has been elected president, with headquarters at New York and Buffalo, N. Y., to succeed Seth A. Crone, deceased. Alfred F. Crone, assistant to president, has been elected vice-president, with headquarters at Buffalo.

THE DEARBORN CHEMICAL COMPANY is completing an extension to its main manufacturing plant, located in the Central Manufacturing District, Chicago, which will result in a 16 per cent increase in floor space. This, the third major addition in 12 years, will be used for a modern machine shop and new equipment for increased business. At the same time the laboratories have been remodeled and new equipment installed. Factory offices have been remodeled and air conditioned.

FRANK H. PRESCOTT, general manager of Delco Products Corporation, division of General Motors Corporation, with headquarters at Dayton, Ohio, has been elected vice-president and general manager of the Electro-Motive Corporation, La Grange, Ill. This will permit H. L. Hamilton, president and general manager, to devote more time to general administration.

THOR M. OLSON has been appointed sales manager of the Ex-Cell-O Aircraft & Tool Corporation, Detroit, Mich., succeeding Wm. F. Wise. Mr. Olson was general manager of the Continental Tool Works from the time it was founded until shortly before it was acquired by Ex-Cell-O in 1930, during the latter part of this period being president of the company. After becoming associated with the Ex-Cell-O Corporation, Mr. Olson became vice-president and a director, in which capacity he took an active part in sales work.

WILLIAM E. CROCOMBE, president of the American Forge Division of the American Brake Shoe & Foundry Company, and president of the American Manganese Steel Company, has been elected also vice-president of the American Brake Shoe &

William E. Crocombe

Foundry Company with headquarters in Chicago. Mr. Crocombe started in the steel business as an office boy under Don H. Bacon of the Minnesota Iron Company, the Minnesota Steamship Company and the Duluth & Iron Range Railroad Company. When these companies were consolidated with the United States Steel Corporation, Mr. Crocombe entered the employ of the Illinois Steel Company in the rail mill and open hearth departments at the South Works. In 1907 he entered the employ of the Lackawanna Steel Company at Buffalo, N. Y., and from 1909 to 1915 was employed by the Union Drop Forge Company at Chicago. In the latter year he organized the forge department of the Ajax Forge Company, now the American Forge Division of the American Brake Shoe & Foundry Company. In 1924 he was elected president of the American Forge Company, now the American Forge Division of the American Brake Shoe & Foundry Company, and in 1933 was elected president of the American Manganese Steel Company.

R. B. MCCOLL, who has been elected president, member of executive committee, and director of Alco Products, Inc., was born in 1882 at Kilmarnock, Scotland, where he attended the Kilmarnock Academy and the Science and Art College.

R. B. McColl

After serving a special apprenticeship and working in various departments on the Glasgow & Southwestern, he was employed by Robert Stephenson & Sons, locomotive builders, Darlington, England, as a draftsman. In 1905 he went to the Montreal Locomotive Works, Ltd., Montreal, Canada, and served in several departments until he became assistant superintendent, then superintendent of works and finally works manager. In 1917 he was appointed manager of the Munitions Department of the Eddystone Munition Company, where he served until after the Armistice. Returning to England he was appointed general manager of the Armstrong Witworth Company's locomotive department, in charge of the building and equipping of the locomotive works and of the sales, engineering and manufacturing of locomotives. Later, in addition, he was made general manager of the pneumatic tool department, gas and oil engine department, and director of the Works Board of all the company's plants, which included shipbuilding and the construction of Diesel-oil engines for marine work, etc. Mr. McColl is still a member of the Institute of Mechanical Engineers, London, England. In January, 1922, he became attached to the New York office of the American Locomotive Company; the following June he was appointed assistant manager of the Schenectady plant, and in January, 1925, became manager of the plant. In 1931, he was elected president and director of the McIntosh & Seymour

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Corporation, Auburn, N. Y., a division of the American Locomotive Company. Recently, when the McIntosh & Seymour Corporation was merged with the parent company, Mr. McColl was appointed vice-president of the American Locomotive Company, Diesel Engine Division, which position he held at the time of his election as president of Alco Products, Inc.

Charles Gaston, a service engineer in the Railroad Department of the Ashton Valve Company at Chicago, has been appointed railroad representative, with headquarters at 21-23 Albany street, New York, succeeding Harry O. Fettinger, deceased.

C. Gaston

Mr. Gaston was born and educated in the vicinity of Louisville, Ky. He was employed as air-brake machinist and foreman and enginehouse foreman on several railroads, his last railroad service having been with the Baltimore & Ohio Chicago Terminal. In February, 1923, he entered the service of the Ashton Valve Company, being located at Chicago until his appointment as railroad representative to succeed Mr. Fettinger. Mr. Gaston is the inventor of the Quadruplex air-brake gage.

John L. Davidson, mechanical engineer of the Valve Pilot Corporation, New York, has been appointed vice-president, with headquarters at New York, the duties assumed with the new office being in addition to those of mechanical engineer. Mr. Davidson was born on July 1, 1894, at Kingston, Ga. After attending the public schools of Quitman, Ga., he entered the Georgia School of Technology, Atlanta, where he received his degree in mechanical engineering in 1915. For about one year after graduation he served as special apprentice in the munitions plant of the Westinghouse Air Brake Co., Wilmerding, Pa., leaving in the spring of 1916 to become a special apprentice in the locomotive shops of the New York Central, at Elkhart, Ind. During the war he secured leave of absence and served in the ordnance department of the United States Army, first as chief army inspector at the Illinois Steel Co., Gary, Ind., and later in an officer's training school at Erie Proving Ground, Ohio. At the close of the war he resumed his training course with the New York Central and after completing it held a number of positions in the test and motive power departments, finally being appointed special engineer in the office of the superintendent of fuel and locomotive performance, from which position he resigned in 1929 to become mechanical engineer of the Valve Pilot Corporation.

H. D. Whittlesey, first vice-president and director of sales and distribution, of the Sherwin-Williams Co., Cleveland, Ohio, has been relieved of the duties of director of sales and distribution, and is now devoting his entire time to executive duties and to the further interests of this company's allied connections. A. W. Steudel, who was vice-president, is now vice-president and general manager of the company. K. H. Wood, who has had territorial and division sales experience and for several years has been in charge of railway and marine sales, is now director of sales and distribution of the company.

Frank P. McEwen, formerly southern sales manager of the Oliver Iron & Steel Corp., has been appointed assistant manager of sales of the Upson division of Republic Steel Corp., with headquarters at Cleveland, Ohio. The Upson division is concerned with the manufacture and sale of bolts and nuts. Mr. McEwen was born at Nashville, Tenn., and his first connection was with the Nashville, Chattanooga & St. Louis in the freight department. He left there in 1912 to become commercial agent in charge of solicitation of the Clinchfield Railroad. In April 1917, he enlisted in the Army and was soon com-

Frank P. McEwen

missioned first lieutenant in the 30th Division of the 115th Field Artillery. After spending fourteen months in France, he returned to the Clinchfield Railroad as general western agent. In 1928 he was appointed district sales manager of the Oliver Iron & Steel Corp., and remained with that company until his appointment with the Republic Steel Corp.

Raymond E. Zahnizer, who has been in the service of the Jones & Laughlin Steel Corporation since 1912 and for the past 10 years connected with its New York district sales office, has been appointed assistant manager of sales, tin mill products, to succeed William Miller, who was recently appointed manager of sales, sheet and strip mill products. Harold L. Dublin, formerly district sales manager of Follansbee Brothers, at Cleveland, Ohio, who had been with that company for 24 years, has joined the Cleveland office of the Jones & Laughlin Steel Corporation to handle the sale of sheet and strip in that territory.

David Dasso, recently elected vice-president of the American Locomotive Company, Diesel Engine Division, was born in Lima, Peru, in 1891. He attended the School of Engineers, Lima, Peru; one year in the department of engineering, University of Illinois, and in 1912 graduated in mechanical engineering at the Massachusetts Institute of Technology. After a trip through Europe, inspecting machinery manufacturing plants, he re-

David Dasso

turned to Lima, Peru, and took over the management of the Vulcan Iron Works, Peru's most important machine shop and foundry. Shortly after taking over the management of the Vulcan Iron Works, he secured the agencies for various select lines of imports, including automobiles, trucks, and Diesel engines. As a corollary to the automobile equipment he inaugurated the first service station in South America. Later he secured the agency of Sulzer Brothers, Ltd., of Winterthur, Switzerland. Subsequently, Mr. Dasso was engaged in the installation of industrial and governmental projects in South America. In the fall of 1932, he was appointed Sulzer Brothers' representative in New York, which position he held, with the exception of one year, 1935-1936, when he was managing director of Sulzer Brothers' office in Buenos Aires, until his present election as vice-president, American Locomotive Company, Diesel Engine Division.

Arthur S. Goble has been appointed manager of the Philadelphia district of the Baldwin Locomotive Works, relieving Stewart McNaughton who will devote his full time to his duties as general sales manager. Mr. Goble graduated from the University of Illinois in 1904 and immediately entered the employ of the Chicago & North Western as assistant to the chemist and engineer of tests. In 1911 he left the railroad to enter into sales work for the Baldwin Locomotive Works, first in New York and later in Chicago. Between the years 1918 and 1932 Mr. Goble was district manager of the Baldwin office in

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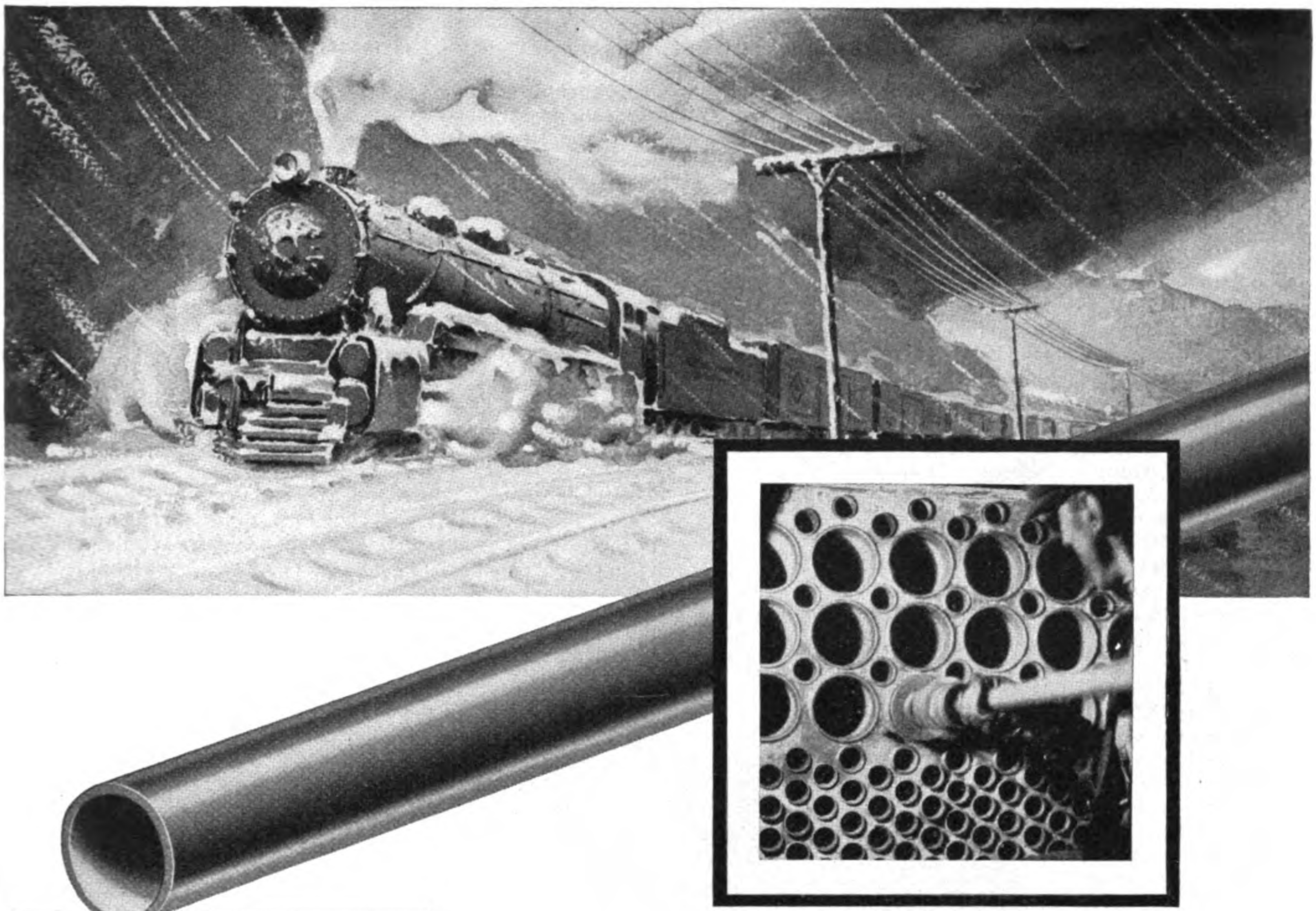

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St. Louis, Mo. For the next two years, he was vice-president of the Hanna Stoker Company, returning to Baldwin on June 1, 1934. From that date until his appointment as manager of the Philadelphia district, he has been engaged in sales work with headquarters in the home office at Philadelphia, Pa.

LEWIS W. METZGER, JR., has been appointed sales representative of The Baldwin Locomotive Works, covering the southern railroads, formerly covered by the late William B. Keys. Mr. Metzger attended school in the East and, in 1913, entered the employ of The Baldwin Locomotive Works as a special apprentice. In May, 1917, he left Baldwin to serve as machine shop foreman with the Bethlehem Steel Company, leaving that position in July, 1919, to return to Baldwin. From March, 1920, until his present appointment, he has been engaged in sales work for both the Baldwin Locomotive Works and the Standard Steel Works Company, in Houston, Texas, Richmond, Va., and in the home office at Philadelphia, Pa.

C. D. ALLEN has been appointed representative of the J. S. Coffin, Jr., Company, Englewood, N. J. Mr. Allen was born on August 5, 1887, at Mount Holly, Vt., and received his education at the Rochester High School, Mount Hermon Preparatory School and Toronto Technical School. In 1906 he entered the employ of the Central Vermont and in 1910 became locomotive engineer at St. Albans, Vt. He became a locomotive engineer on the Canadian National in June, 1914, and later served as locomotive foreman. In 1920 he became railway sales and service manager of T. McAvity & Sons of Canada, and from April, 1927, until this year was, consecutively, salesman, service engineer and development engineer of Manning, Maxwell & Moore, Inc.

Obituary

J. VICTOR BELL, who retired, because of ill health in 1930 as southwestern sales manager of the American Steel Foundries, Chicago, died on October 8, in Marshall,

J. Victor Bell

Tex. Mr. Bell was born in that city on June 11, 1868, and entered the service of the Texas & Pacific in 1886, where he was employed in the car department until 1895, at which time he became associated with the American Steel Foundry Company. He continued in the employ of this company, which later formed a part of the American Steel Foundries, until his retirement, with the exception of a short period in 1903 when he was located at Mexico City, D. F., as manager of the Waters-Pierce Oil Company. During his association with the American Steel Foundries he was in charge of the St. Louis office and in 1926 was appointed southwestern sales manager.

SETH A. CRONE, president of the Buffalo Brake Beam Co., died at his home in Montclair, N. J., on October 16. Mr. Crone was born on January 6, 1859, at New Market, Ontario. He entered railway service in 1878 with the Quincy, Missouri & Pacific, now the Quincy, Omaha

Seth A. Crone

& Kansas City. From March, 1879, to July, 1882, he was in the car shops of the Missouri Pacific, then to June, 1884, general foreman of the car department of the Texas & St. Louis, now part of the St. Louis Southwestern. He later served as foreman of the Pullman Palace Car Co., until July, 1885, and later, to April, 1886, as assistant superintendent of the Mann Boudoir Car Co. From April, 1886, to October, 1887, he was assistant superintendent of the Chicago and Northwestern district of the Wagner Palace Car Co., and then to March, 1888, was superintendent of the same district for the same company. In March, 1888, he was appointed inspector of equipment on the New York Central & Hudson River and from May, 1891, to June 1, 1899, was superintendent of rolling stock of the same road. In 1900 he was appointed manager of the Spiral Nut Lock Co. In 1902 Mr. Crone organized and became president of the Buffalo Brake Beam Co. During the period 1897 to 1899 Mr. Crone was president of the Master Car Builders Association. At the time of his death he was president and a director of the Buffalo Brake Beam Co., and the Acme Steel & Malleable Iron Works, and a director of Dominion Foundries & Steel, Ltd., Hamilton, Ontario.

HENRY ELLSWORTH MORTON, president of the Morton Manufacturing Company, died at his home in Muskegon Heights, Mich., on September 29, at the age of 73. Mr. Morton for 58 years had been active in the development of Morton draw-cut machine tools.

FRANK N. GRIGG, formerly in the railway supply business, died on September 22, at San Diego, Cal., where he went several years ago because of ill health. Mr. Grigg was born 62 years ago; he served on the Chesapeake & Ohio and later with the Adams & Westlake Company. Before going to California, Mr. Grigg was in the railway supply business in Washington, D. C., and among other companies he represented the Morton Manufacturing Company, the Tuco Products Company, the Heywood-Wakefield Company and the Harlan & Hollingsworth Car Company.

Personal Mention

General

W. R. ELSEY, superintendent of floating equipment for the New York Zone of the Pennsylvania and the Long Island at Jersey City, N. J., has been promoted to mechanical engineer of the Pennsylvania, with headquarters at Altoona, Pa. Mr. Elsey was born on April 1, 1892, at Pittsburgh, Pa. He was educated in the public schools of Pittsburgh and Carnegie Institute of Technology. Mr. Elsey entered railroad service on September 26, 1911, with the Pennsylvania and served until 1916 as draftsman at South Pittsburgh, Pa. He then became piecework inspector at Shire Oaks, Pa., and from 1917 to 1920 served as shop inspector at South Pittsburgh. Mr. Elsey served as assistant master mechanic at Canton, Ohio, from 1920 to 1921 and from the latter year until 1923 was motive power inspector at Pittsburgh. From 1923 to 1928 he was assistant master mechanic at Johnstown, Pa., and in the latter year became master mechanic at Baltimore, Md. Mr. Elsey was appointed acting superin-

Bachrach

W. R. Elsey

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tendent floating equipment at New York in 1929 and became superintendent floating equipment in 1930.

H. L. NANCARROW, master mechanic of the Philadelphia Terminal division of the Pennsylvania at Philadelphia, Pa., has been appointed superintendent of the Logansport division, with headquarters at Logansport, Ind. Mr. Nancarrow, who is a graduate of Bucknell university, entered the service of the Pennsylvania on October 7, 1920, as a draftsman in the office of the superintendent of motive power at Philadelphia, Pa. On March 14, 1921, he became a special apprentice at the Altoona (Pa.) machine shops, and on April 17, 1924, inspector of motive power at the same point. On September 1, 1924, he became a gang foreman on the Cleveland and Pittsburgh division and on February 10, 1926, was promoted to assistant enginehouse foreman. Mr. Nancarrow was transferred to the Akron division as assistant master mechanic on March 1, 1927, and on May 16, 1928, was appointed to master mechanic of the Erie and Ashtabula division. On January 1, 1929, he was transferred to the Baltimore division, and thence to the Philadelphia Terminal division.

H. L. Nancarrow

Master Mechanics and Road Foremen

B. W. JOHNSON, assistant road foreman of engines, Baltimore division, of the Pennsylvania, has been appointed assistant road foreman of engines, New York division.

C. O. SHULL, master mechanic of the Chicago Terminal division of the Pennsylvania, has been transferred to the Philadelphia Terminal division, Philadelphia, Pa., to succeed H. L. Nancarrow.

W. R. DAVIS, assistant master mechanic of the Philadelphia division of the Pennsylvania, with headquarters at Harrisburg, Pa., has been appointed master mechanic of the Chicago Terminal division, succeeding C. O. Shull.

J. D. DAVENPORT, assistant master mechanic of the Chesapeake & Ohio, has been appointed master mechanic of the Hinton division, with headquarters at Hinton, W. Va. The position of assistant master mechanic has been abolished.

R. K. FLANAGAN, assistant master mechanic of the Chesapeake & Ohio at Huntington, W. Va., has been appointed master mechanic of the Huntington division, with headquarters at Huntington. The position of assistant master mechanic has been abolished.

GEORGE HENRY NOWELL, who has been appointed master mechanic of the Canadian Pacific at Moose Jaw, Sask., as noted in the August issue of the *Railway Mechanical Engineer,* was born on November 13, 1884, at Montreal, Que. He received a public and high-school education and on July 2, 1899, became a machinist apprentice in the employ of the Canadian Pacific. From July 2, 1904, to November 5, 1904, he served as a machinist at Montreal, and then until April 15, 1905, as a machinist at North Bay, Ont. During the next five months he was a machinist on the Grand Trunk at Montreal, returning to the Canadian Pacific on September 1, 1905. On September 30, 1908, he became leading hand at Montreal; on January 15, 1910, charge hand at Montreal; on January 15, 1913, erecting shop foreman at Ogden, Alta.; on March 19, 1914, acting locomotive foreman at Ogden, and on September 4, 1915, locomotive foreman at Cranbrook, B. C. On December 1, 1915, he was appointed division master mechanic, serving at Nelson, B. C., until April 10, 1919; at Revelstoke, B. C., until February 10, 1920; at Lethbridge, Alta., until January 1, 1929; at Regina, Sask., until March 15, 1936, and at Moose Jaw, Sask., until July 1 of this year when he became master mechanic at Moose Jaw.

Car Department

G. P. KERBY has been appointed assistant foreman, air brake shop, of the Canadian National, with headquarters at Transcona, Man., succeeding K. F. Stortts, retired.

Shop and Enginehouse

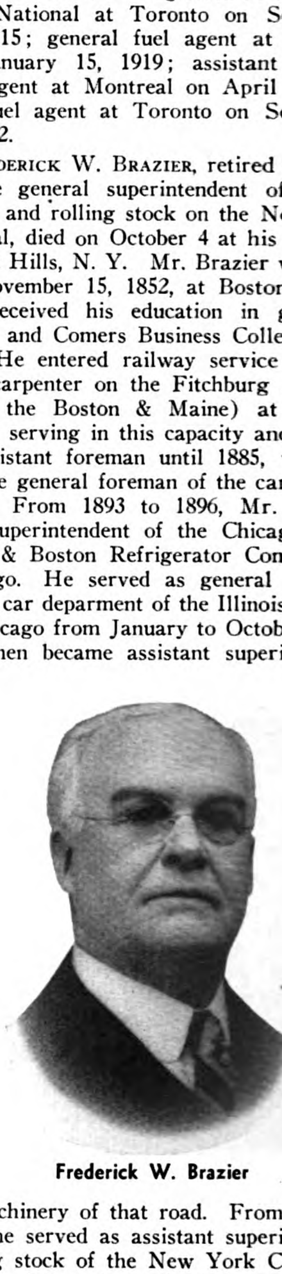
HERBERT WATSON has been appointed acting locomotive foreman of the Canadian National, with headquarters at Sydney, N. S.

J. M. CLARK, shop engineer of the Canadian National at Transcona, Man., has been appointed inspector of tools and machinery, with headquarters at Winnipeg, Man., succeeding W. E. Siler, retired.

Obituary

ARTHUR L. GRABURN, who retired on June 1, 1935, as fuel agent of the Canadian National at Toronto, Ont., died on September 25 at the Ontario Club, Toronto. Mr. Graburn became a clerk in the employ of the Canadian Pacific at Winnipeg, Man., on February 27, 1885; a clerk on the Chicago Great Western at South Park, Minn., on May 1, 1888; a foreman on the Chicago, St. Paul, Minneapolis & Omaha, at St. Paul, Minn., on July 1, 1890; a clerk on the Canadian Pacific at Winnipeg, Man., on October 15, 1890; a wiper on the Canadian Pacific at Winnipeg, on February 15, 1891; news agent on the Canadian Pacific at Winnipeg on September 10, 1891, and an accountant on the Northern Pacific at St. Paul, Minn., on October 5, 1891. He was appointed superintendent of shops of the Great Northern at Great Falls, Mont., on June 1, 1899, and superintendent of shops at St. Cloud, Minn., on June 1, 1900. From September 9, 1906, to November 30, 1907, he was a supplyman at St. Paul. He returned to the Chicago Great Western as an accountant at St. Paul on January 28, 1908, and to the Canadian National on November 16, 1908, as mechanical engineer at Toronto, Ont., He became assistant superintendent of rolling stock of the Canadian National at Toronto on September 23, 1915; general fuel agent at Toronto on January 15, 1919; assistant general fuel agent at Montreal on April 1, 1923, and fuel agent at Toronto on September 1, 1932.

FREDERICK W. BRAZIER, retired assistant to the general superintendent of motive power and rolling stock on the New York Central, died on October 4 at his home in Forest Hills, N. Y. Mr. Brazier was born on November 15, 1852, at Boston, Mass., and received his education in grammar school and Comers Business College, Boston. He entered railway service in 1877 as a carpenter on the Fitchburg Railroad (now the Boston & Maine) at Boston, Mass., serving in this capacity and in that of assistant foreman until 1885, when he became general foreman of the car department. From 1893 to 1896, Mr. Brazier was superintendent of the Chicago, New York & Boston Refrigerator Company at Chicago. He served as general foreman of the car deparment of the Illinois Central at Chicago from January to October, 1896, and then became assistant superintendent of machinery of that road. From 1899 to 1904 he served as assistant superintendent rolling stock of the New York Central & Hudson River (now the New York Central) and from 1904 to 1920 was superintendent rolling stock of the New York Central. Mr. Brazier served as assistant to general superintendent motive power and rolling stock of the New York Central from 1920 until his retirement in 1932. He was a past president of the Master Car Builders' Association.



Frederick W. Brazier

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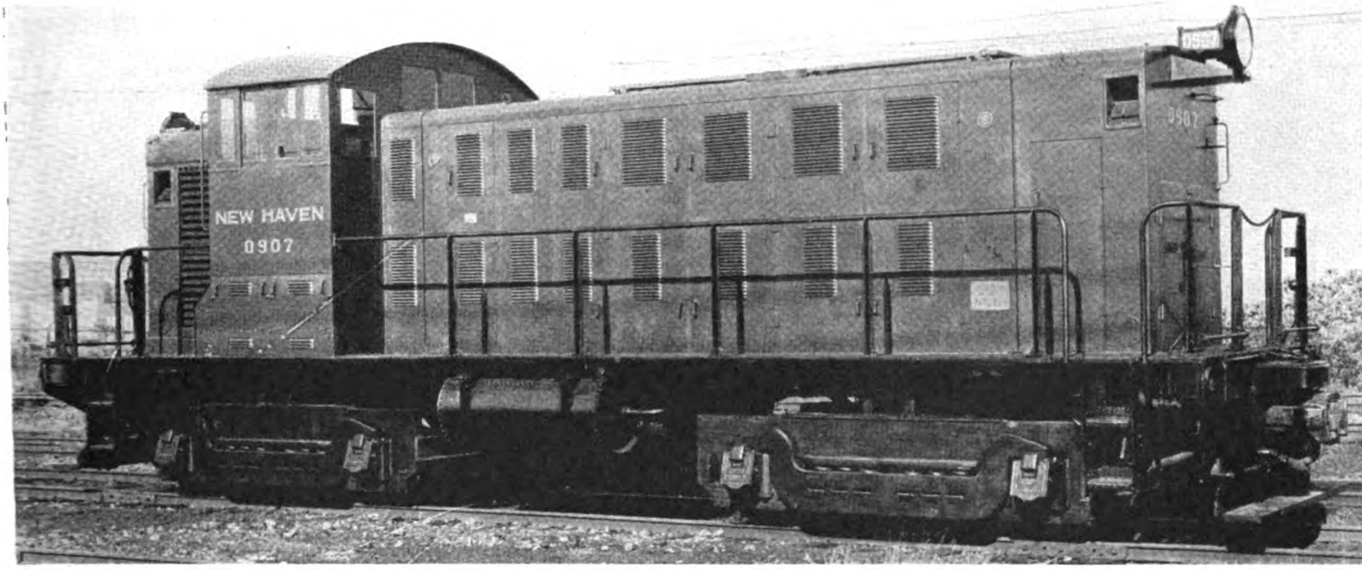
**RAILWAY
MECHANICAL ENGINEER**



Ten of these Diesel-electric switchers have gone into service on the New Haven

Co-ordination of Major Equipment Units Features

New Haven Diesel Switchers

Ten Diesel-electric units built by the General Electric Company are powered by Cooper-Bessemer and Ingersoll-Rand engines. Welded construction utilized in underframes, engine bases, cabs and trucks

WITHIN the last three weeks the New York, New Haven & Hartford has placed in service the first of an order of ten Diesel-electric switching locomotives which involve some unusual considerations in design and equipment. Five of these locomotives are powered with Ingersoll-Rand 600-hp. Diesel engines and the remaining five with 660-hp. Cooper-Bessemer engines. The locomotives have been designed to operate at speeds not exceeding 25 m.p.h., the railroad having considered it desirable to sacrifice higher speeds of from 25 to 45 m.p.h. in return for an increase of approximately 10 per cent in low-speed performance.

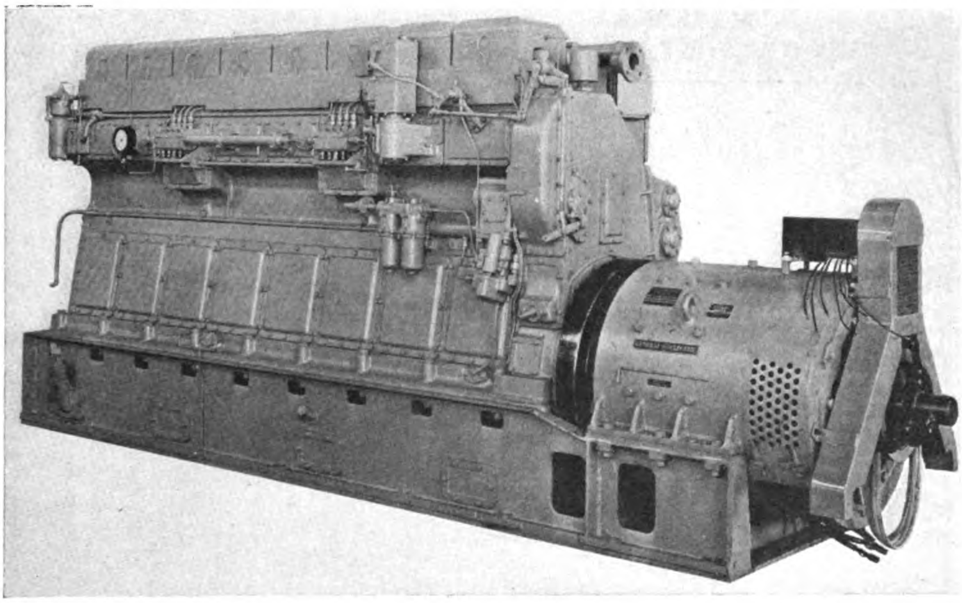
In these locomotives the designers have done an exceptional job of co-ordinating the equipment in such a manner that it is possible to interchange the prime movers despite the fact that two different makes of engines are used.

Co-ordination of Equipment

Co-ordination was carried out along three lines. One was the determination of the maximum operating characteristics of the two engines from a study of which could be designed a common set of engine auxiliaries and secondary apparatus, including parts of the electrical equipment; another was the co-ordination of all operating procedures so that with minor variations the same set of instructions could be used with locomotives having either make of engine; the third was the actual employment for both engines of the same auxiliary parts.

One of the first major considerations was the design of a generator which with its field-control equipment would have a speed-torque characteristic suitable for both engines. Each builder, therefore, submitted a permissible speed-torque curve for his engine and a generator was designed with acceptable characteristics over the entire speed range. Governed speed at full load was set at 770 r.p.m. for each engine, the speed control equipment being designed to maintain speed at full load just under this, or at 750 r.p.m. It can thus be seen that there will be no conflict between engine governor and electrical governor.

To design suitable starting characteristics for both en-



Five of the locomotives are equipped with eight-cylinder Cooper-Bessemer four-cycle Diesel engines having 10½-in. by 12-in. bore and stroke and developing 660-hp. at 750 r.p.m.

gines, the engine builders furnished information regarding maximum torque required at breakaway to overcome compression at 32 deg. F., torque at minimum firing speed at 32 deg. F., and minimum firing speed in r.p.m. With this information and knowing the battery characteristics, the starting winding on the generator could be correctly designed and proportioned for starting both types of Diesel engines.

Rotation as finally agreed upon for both engines was clockwise facing the generator end.

Mechanical design of the generator and coupling as they affected the rotating systems of the engines was given very careful attention. The final design incorporated WR^2 and stiffness factors acceptable to both engine builders.

Idling speed was finally decided upon as 300 r.p.m. at full auxiliary load of 40 hp.

A new flexible coupling was designed for use with both engines. This coupling employs steel discs which transmit torque in compression and allow slight movements longitudinally by bending. Engine flywheels to which the couplings were attached were different, but were made suitable for attaching the same generator fan.

After collecting from each engine builder data regarding heat rejection to cooling water, engine outlet water temperature water pump delivery and head, etc., a water cooling system was designed which was suitable for both engines and which had incidentally an inherent capacity suitable for the larger engine operating continuously at full load in an ambient temperature of 100 deg. F.

A serious attempt was made to use the same water pump on both engines, but after full investigation this was abandoned and each engine was equipped with its own type of pump.

The same water temperature indicators with the same markings were designated as were identical thermostat switches set at the same cut-in and cut-out points. Similar data regarding lubricating oil were collected, and provisions made in arrangement of water radiators for the inclusion of the necessary oil radiators.

Since one engine used a nominally constant lubricating oil pressure system and the other a variable system there was some question as to the co-ordination of the lubricating-oil pressure gages. This was answered by using the same gage marked with the minimum allowable oil pressure at idling which was determined to be 20 lb. for both engines.

Two Nugent lubricating-oil filters were installed for each engine. The filters are connected in parallel, and handle the entire lubricating-oil circulation.

Low-pressure fuel-oil systems were completely co-ordinated, and consist of a motor-driven transfer pump, a Purolator filter with .003-in. spaces on the suction side of the pump and Purolator on the discharge side, with necessary trip, relief valve, pressure gage, etc. While it was the railroad's desire to conform to its other Diesel-electric equipment and maintain 35 lb. pressure on the discharge side of the transfer pump, it was necessary to drop this to 10 lb. for one make of engine on account of characteristics of the high-pressure pump.

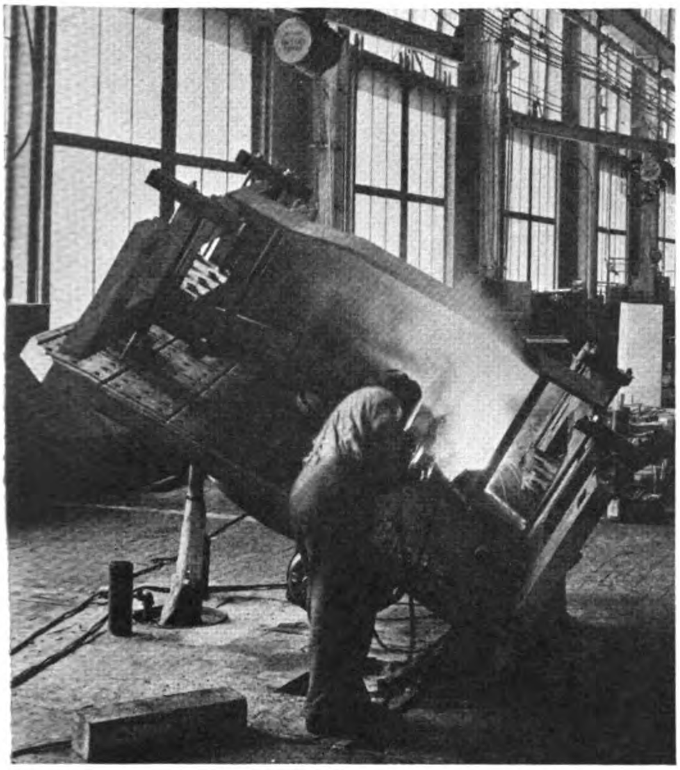
General Characteristics of New Haven Diesel-Electric Switchers

Total weight in working order, lb.	199,000
Light weight, lb.	190,000
Tractive force, starting (0.3 adhesion), lb.	60,000
Tractive force, continuous at 6.35 m.p.h., lb.	26,000
Maximum speed, miles per hour	25
Length over coupler knuckles, ft. and in.	41-0
Truck center distance, ft. and in.	21-0
Truck wheel centers, ft. and in.	8-0
Total wheel base, ft. and in.	29-0
Wheel diameter, in.	33
Width over cab sheets, ft. and in.	9-8¾
Heights from rail:	
Cab floor, ft. and in.	4-0
Overall, ft. and in.	13-11
Capacity of fuel-oil reservoir, gallons	400
Capacity of lubricating-oil reservoir (one engine), gallons	100

No co-ordination was attempted on the high-pressure fuel systems of either engine, partly because of the inherent differences between the so-called "common rail" and "jerk pump" systems, and partly because it was not desired that changes be made in fundamental parts of the engines.

Mufflers are made integral parts of each engine both for the sake of inter-changeability of the Diesel engines as between locomotives and to keep mufflers off the top of the locomotive to improve visibility from the cab. Suitable provisions were made in the hood around the exhaust exit so that the exhaust stacks of either engine were equally well accommodated and were hidden from view behind a low collar which conforms to the contour of the hood.

Four Air-Maze intake air filters of the same type and size were used on each engine. The housings, however, on the two were of different size and arrangement; on one the filter units themselves extended the length of the engine and came out close to the upper row of louvers in the hood; on the other there was a form of air duct at each end leading to a common housing in which were



Welding one of the truck frames

the filter units. Since this engine is narrower than the other it was necessary that filler pieces be fitted in between the louvers and the face of the ducts; these were fastened to the two hood doors opposite. To carry out the co-ordination scheme consistently, the corresponding hood doors were drilled and fitted with bolts on locomotives having the other kind of engine though of course, the filler pieces were installed only on the engine requiring them.

In order to gain a direct operating comparison between two types of speed control equipment, the Woodward governor was furnished on one type of engine, and a mechanical type with servo-motor on the other. Both engines were equipped with overspeed trip, lubricating-oil pressure relay to protect against low oil pressure, and solenoid-operated fuel shut-off device. While most of this equipment was different on the two engines, nevertheless the methods of operation were identical. The throttle mechanism was made identical both as regards operation and adjustments.

One particularly important problem of co-ordination arose because of the fact that one engine weighed roughly 7,000 lb. more than the other and that one engine had a dry base and the other a sump base. Since both engine-generator sets in the locomotive had to be identical as to number, size and spacing of bolt holes, method of mounting, etc., the problem was settled by re-designing the sub-base of the lighter engine, making the bottom of a plate 2¾ in. thick. This new sub-base made up nearly 6,000 lb. of the 7,000 lb. difference in weight. The fact that this same engine used separate mufflers attached to it instead of the combined manifold and muffler arrangement still further reduced the difference, so that the weight discrepancy factor disappeared.

The sub-base of the engine designed for an outside sump was redesigned to incorporate in it a lubricating oil reservoir of 100-gal. capacity. This eliminated the necessity for a separate sump tank for this oil and made it possible to design similar filling, draining and gaging facilities for the two makes of engines.

It was the railroad company's desire that the crank-case breather pipe for both engines open directly into the engine compartment without having it piped underneath or into the air intake system. Hence each engine has a 2-in. pipe fitted with a Vortex filter cap.

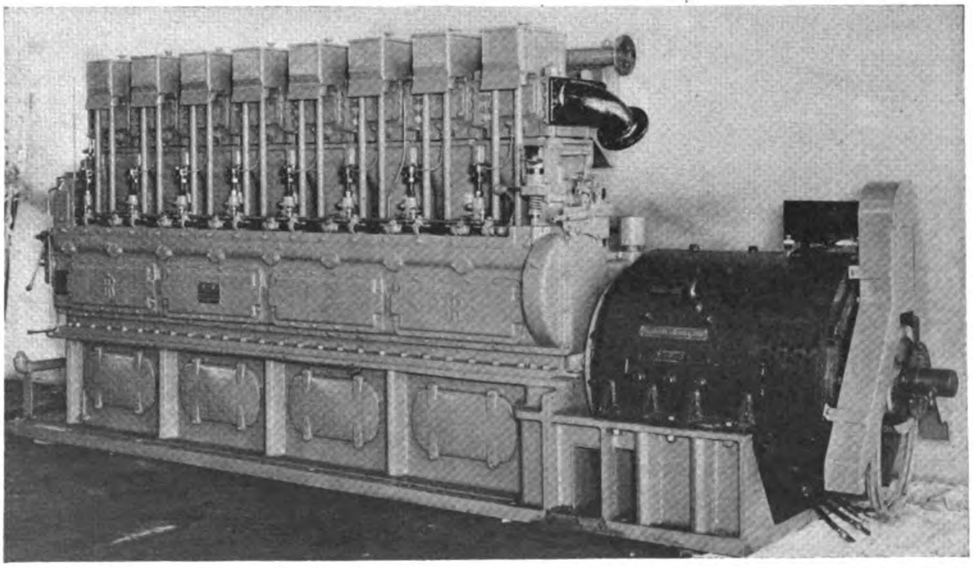
One of the most detailed parts of the co-ordination was the arrangement of all fuel-oil, lubricating-oil, water and drain lines on each engine so that they would connect with a common system of locomotive piping. The center line of the crankshaft and the bolting face of the generator coupling were taken as references for locating pipe connections. While doing this has resulted in both engine builders having to run extra piping on their engines, the net effect has been a uniform arrangement of locomotive piping.

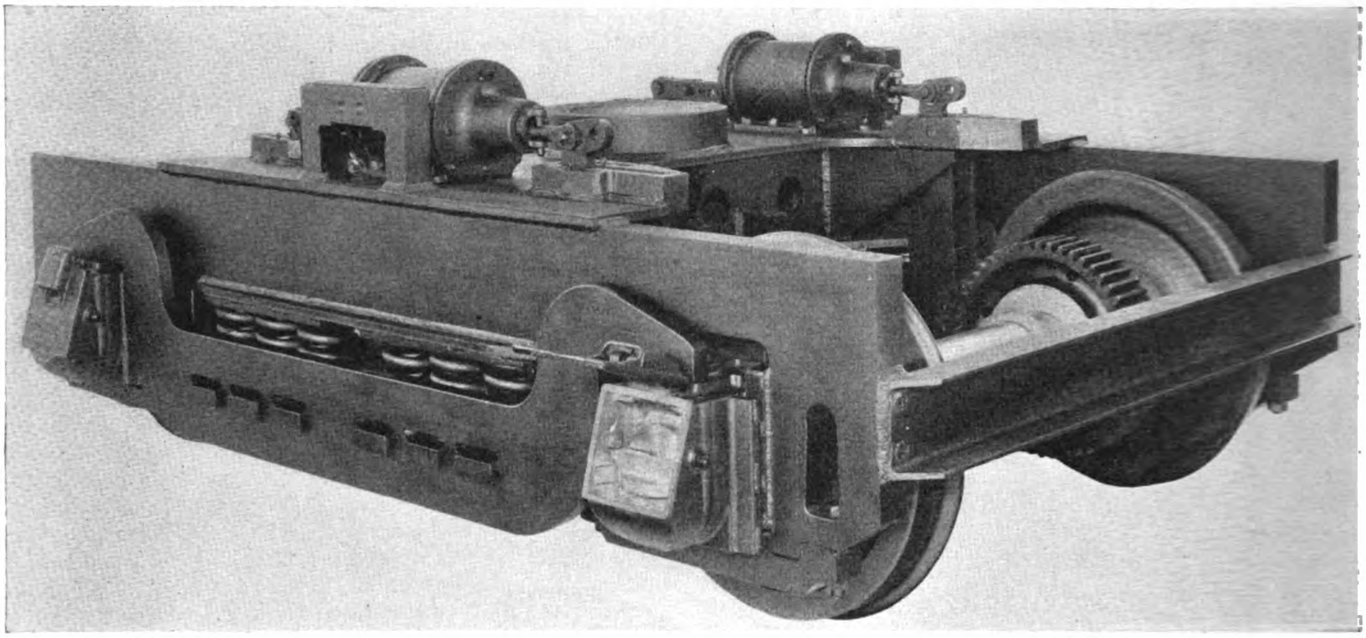
Trucks

Perhaps the most noteworthy feature of the mechanical structure is the all-welded truck construction, including the truck frames. These trucks are built up of structural shapes and plates knit together by heavy fillet and plug welds. The true test of their value comes in a severe derailment, in which one of these locomotives has already been involved through no fault of its own, and these trucks have proved themselves less subject to damage than those of other construction.

The weight of the locomotive is carried entirely on

One of the five 600-hp. eight-cylinder, four-cycle Ingersoll-Rand engines showing the welded steel sub-base and generator mounting. These engines develop their rated horsepower at 750 r.p.m.





The trucks are of welded, fabricated construction—The weight of the locomotive is carried on nests of coil springs

nests of coil springs mounted between the truck frame and equalizers. The construction is simple and the riding qualities of the locomotive exceptionally good. Additional features are the combined side-bearing and locking arrangement, and the truck swivel-limiting member which is attached to the front cross tie, contacting pads on the draft-gear housing. Lateral thrust of the axle is taken by thrust blocks mounted in the journal boxes opposite the ends of the axle.

A feature of the brake work is the provision for partial brake-travel adjustment by changing the position of the upper end of the dead lever which is on top of the truck and accessible without a pit. Further adjustment is provided by the usual turnbuckle arrangement behind the equalizers.

Arrangement of the controls at the operator's station

The wheels are standard 33-in. tender wheels, thus lowering wheel costs. Journals are the collar type, 6½ in. by 12 in.

Underframe and Cab

The underframe is built up around a main slab 37 ft.-11¼ in. by 117 in. by 1½ in. forming the platform and mounted on two 37-ft.-7½-in. by 10-in. by 6½-in. center sills, running the entire length and forming a stiff backbone for absorbing buffing shocks as well as supporting the main items of equipment. Bumper beam, box structure for reinforcing the ends, draft gear housing, bolster plates, center bearings and buffers are of wholly fabricated welded construction.

The cab and hood are of welded construction throughout. The section of the hood over the engine-generator set is removable and furthermore may be removed without disturbing any of the major piping. For minor work on top of the engine, a hatch is provided in the roof.

Equipment Layout

Accessibility of the equipment was one of the major objectives of the design, since accessibility goes a long way toward assuring low maintenance costs. The following points are of especial interest: Radiator sections can be removed singly from the platform. Radiator blower motor is reached from inside the radiator compartment and lifted out through the fan cone; the radiator compartment is reached through a door in operating cab. Distributing valve is mounted in the radiator compartment and feed valves in the operating cab. Contactors, relays, reverser and other control apparatus are reached from the operating cab through folding doors and resistors from the generator compartment. Batteries are reached from the ground through drop doors on the sides of the operating cab. The generator is in a separate compartment from the Diesel engine and is reached through hinged doors from the platform. All sides of the compressor are accessible through doors in the hood. Access to the entire length of the engine from top to bottom on both sides is provided by a series of hinged doors along the platform.

Operating Cab and Control Station

Particular pains were taken in laying out the control station so as to provide greatest convenience for the operator and best possible visibility. To this end, a com-

plete dummy cab and operator's position were set up in the early stages of the design and apparatus, controls, seat, windows, etc., readjusted until it was felt the best possible arrangement had been achieved. The controls are convenient regardless of direction of operation. The operator can look across the top of either hood and see cars or locomotives on the other side, a real advantage in yard work. By putting the radiator ahead of the operating cab, no sacrifice in visibility is made and the operator is given greater protection in case of collision.

Cooper-Bessemer Engine

The eight-cylinder Cooper-Bessemer engines are the type G-N8 four-cycle arranged in line. They have 10½-in. bore by 12-in. stroke cylinders, rated at 660 b.hp., continuous at 750 r.p.m. They are of the dry base type, carrying a structural steel sub-base, into which is built a lubricating-oil sump tank. This sub-base maintains accurate alinement of the engine and generator. The cylinder block and bottom of the crank case are cast in one piece, with removable alloy-iron cylinder liners, having top and bottom joints sealed water-tight by round rubber grommets held in turned recesses. The cylinder heads are individual castings, in which fuel nozzles, relief valves, intake and exhaust valves are all mounted and quickly accessible. The engines are equipped with aluminum pistons and 7½-in. diameter crank shafts, providing a combination which eliminates torsial vibration of any consequence within the operating range of the engine. The idling speed of these engines is 300 r.p.m. The connecting rods are high-tensile drop forgings of I-beam section, drilled full length to provide pressure lubrication to the wrist pins. The connecting-rod bearings are removable babbit-lined steel shells at the wrist-pin end and at the top half of the crank-shaft bearing. The bottom half of the crank-shaft bearing is a babbit-lined steel connecting-rod cap. The inlet and exhaust valves, one to each cylinder, are operated by forged rocker arms and short push rods, the lower ends of which rest against hardened cup blocks carried in guides with hardened rollers.

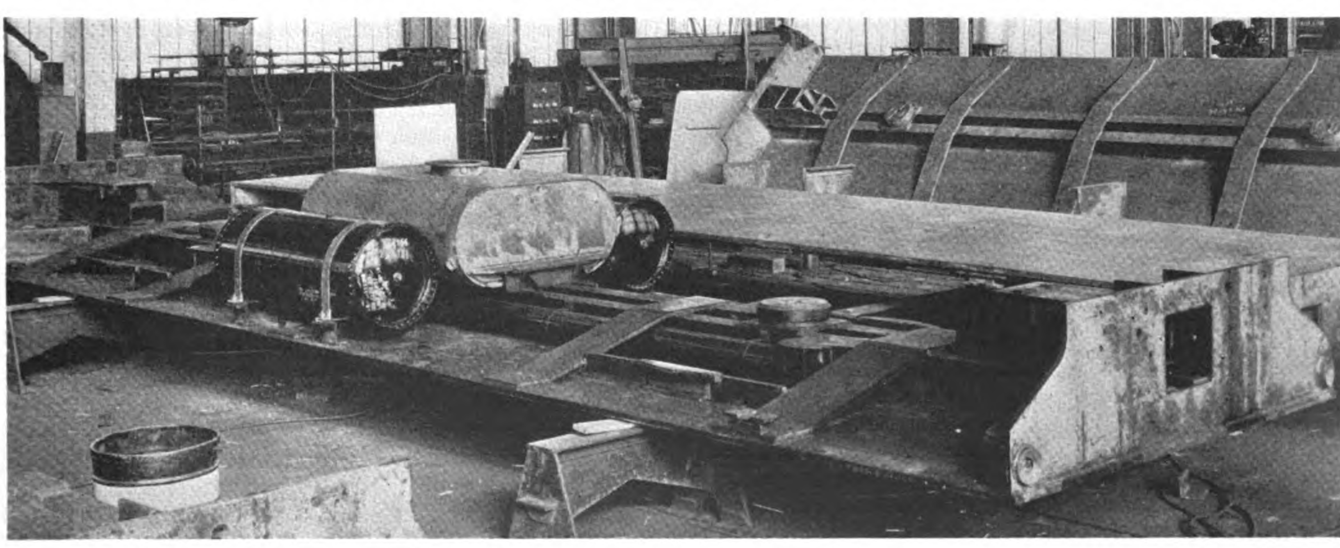
The injection system is the standard Cooper-Bessemer atmospheric-relief type of constant-pressure system, operating at maximum injection pressures of approximately 7,000 lb. and an idling injection pressure of approximately 4,000 lb. The cam-shaft drive, which also serves as the drive for all auxiliaries, is on the fly-wheel end of the engine and consists of a roller chain. The entire engine is enclosed, providing a dust-proof arrangement. The auxiliaries consist of a centrifugal water pump and rotary lubricating-oil pump, in addition to the main fuel pump. There is no drive taken off the forward end of the engine, the thrust bearing being applied at that end. The engines are not equipped with torsional vibration dampeners, as they are unnecessary with this combination of crankshaft and light reciprocating weights.

Ingersoll-Rand Engines

Five of these locomotives are equipped with Ingersoll-Rand railway type Diesel engines of the vertical, trunk-piston, single-acting type, operating on the four-stroke cycle with direct fuel injection. The cylinders, eight in line, are 10-in. bore by 12-in. stroke, and the engines are rated at 600 hp. at 750 r.p.m. The engine sub-base, which supports the engine and generator, is of welded steel construction, extending the full length of the engine, and forms an oil sump for the engine. The cylinder block and upper portion of the crankcase is cast in one piece, with removable cylinder liners. The crank shaft is a one-piece forging, with main bearings 6¼ in. in diameter, drilled to provide passage for the lubricating oil to the main and crank-pin bearings. The crank shaft is counterbalanced. The connecting rods are one-piece drop forgings, with a solid eye at the piston pin end. The connecting rods are drilled for wrist-pin lubrica-

Partial List of Specia'ties on the New York, New Haven & Hartford Diesel-Electric Switchers

Builder	General Electric Co., Schenectady, N. Y.
Diesel engines	(5) Cooper-Bessemer Corp., Mt. Vernon, Ohio (5) Ingersoll-Rand Co., New York
Flexible coupling	Ingersoll-Rand Co., New York
Exhaust mufflers	Burgess Battery Co., Madison, Wis.
Air intake filter	Air-Maze Corp., Cleveland, Ohio
Lubricating oil filters	Wm. W. Nugent Co., Chicago
Gages	Consolidated Ashcroft-Hancock Co., Bridgeport, Conn.
Fuel-oil transfer pump	Ingersoll-Rand Co., New York
Fuel-oil filters	Motor Improvements, Inc., Newark, N. J.
Electric transmission	General Electric Co., Schenectady, N. Y.
Storage battery	Electric Storage Battery Co., Philadelphia, Pa.
Traction motor fans	B. F. Sturtevant Co., Boston, Mass.
Radiators	Modine Mfg. Co., Racine, Wis.
Radiator fans and auxiliary motors	General Electric Co., Schenectady, N. Y.
Hand brakes	Ajax Hand Brake Co., Chicago
Foundation brakes	General Electric Co., Schenectady, N. Y.
Air brakes	Westinghouse Air Brake Co., Wilmerding, Pa.
Air-brake compressors	General Electric Co., Schenectady, N. Y.
Couplers	National Malleable & Steel Casting Co., Cleveland, Ohio
Draft gears	W. H. Miner, Inc., Chicago
Wheels	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Journal boxes	Symington Co., New York
Steam-line fittings and accessories	Vapor Car Heating Co., Inc., Chicago
Steam-pipe insulation	Johns-Manville Corp., New York
Cab radiator	Rome-Turney Radiator Co., Rome, N. Y.
Clear-vision windows	Prime Mfg. Co., Sydney, Ohio
Fire extinguishers	Pyrene Mfg. Co., Newark, N. J. Walter Kidde & Co., Bloomfield, N. J.
Sanders	Graham-White Sander Corp., Roanoke, Va.



Fabricated platform for New Haven locomotive showing underside construction with fuel and air tanks

tion. The wrist-pin bearing in the connecting rod is a bronze-lined steel shell, pressed into the eye. The bearing at the crank-shaft end is an interchangeable babbit-lined steel shell, with a cap forming the bottom half of the bearing. The pistons are of cast iron, ground to size. They contain five compression rings and two oil-control rings. The hollow steel piston pin is of the floating type, and is prevented from coming in contact with the cylinder walls by two brass cover plates, which are held in place by a threaded tube passing through the piston pins. The cylinder heads are individual castings. Each containing one inlet and one exhaust valve, and two opposed spray nozzles. Flanges on the cylinder heads bolt together, forming an integral water-jacketed exhaust manifold.

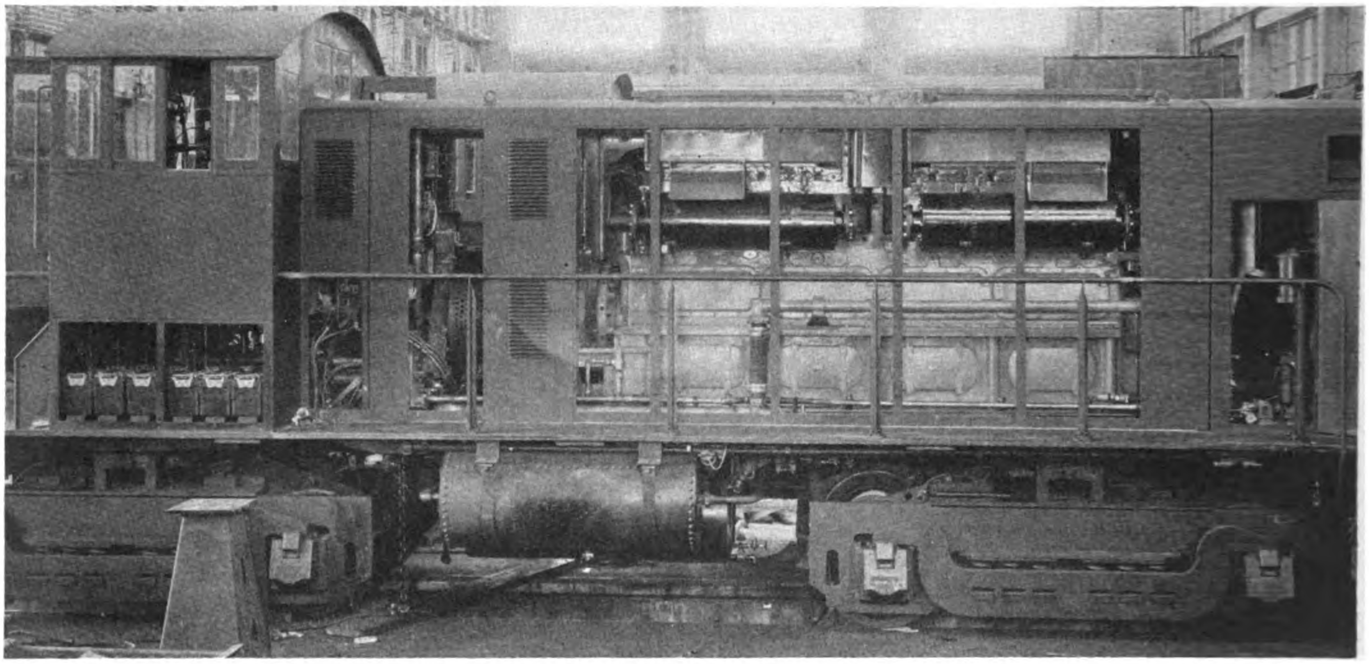
The camshaft carries inlet, exhaust and fuel-pump cams, governor driving gear and over-speed governor. The inlet and exhaust valves are actuated by rocker

strainer, filters, cooling radiators and thence to the engine bearings. The lubricating-oil system is provided with an electric safety switch which stops the engine in the event of failure of the oil supply.

Transmission

The generator is driven through a flexible coupling, the generator being mounted on an extension of the engine sub-base. The generator output varies with engine speed in the conventional way as on any variable-speed engine equipment. At full throttle full engine horsepower is utilized at all speeds from approximately 2 to 15 m.p.h. thus assuring maximum performance of the locomotive within the entire range of switching operation. The excitation is the combined self and separate type.

The traction motor equipment consists of four General Electric type 724 motors which are axle hung,



One of the New Haven locomotives under construction at the General Electric Works at Erie, Pa.—The covers have been removed to show the engine, generator, control and batteries

arms and push rods. The camshaft drive from the crank shaft is by means of an idler gear support on ball bearings. The fuel system consists of a Cameron cam pump motor set, which draws fuel oil from the storage tanks and delivers it under pressure to a filter. Constant fuel pressure is maintained at the filter by a relief valve. From this point fuel oil flows through a header to individual injection pumps, which deliver properly timed and metered quantities of the fuel to the two spray nozzles in each head.

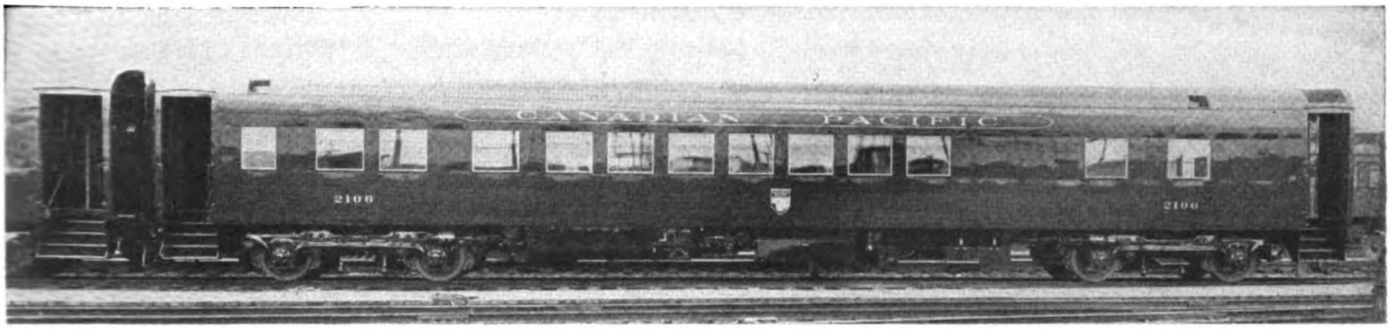
The engines are equipped with a dynamic hydraulic vibration damper, located on the end of the crank shaft away from the generator. The engine governor is driven through bevel gears from the crank shaft, and controls the quantity of fuel delivered to each cylinder. A servo-mechanism is employed to control the governor. The water-cooling system consists of a centrifugal-type pump driven from the crank shaft which delivers water to the jackets of the cylinders and heads. Force-feed lubrication is provided for all wearing parts of the engine. The lubricating-oil supply is stored in the engine sub-base and oil circulation is provided through the medium of a gear-type pump, driven from the crank shaft. Oil drawn from the sub-base passes through a suction

nose suspended units with double reduction drive. There are several reasons for going to a double reduction motor on this equipment. For switching service where the majority of the work is done at speeds of 5 to 8 m.p.h. and maximum speeds rarely exceed 12 to 15 m.p.h. it seemed logical to design a motor the best efficiency of which would occur in this low speed range limiting the maximum speed to about 25 m.p.h. which would take care of transfer work and light movements. Moreover, the armature becomes a high-speed unit and hence comparatively small. The net result is that the GE-724 motor complete with gearing and all accessories weighs 4,500 lb. against 8,100 lb. for motors used previously in similar applications. The smaller motor permits the use of a standard 33-in. tender wheel.

The continuous tractive force rating of each motor is 7,000 lb. giving a total rating of 28,000 lb. at approximately 6 m.p.h.

Traction motors are permanently connected two in series on each truck and two motor connections are used series-parallel full field and series-parallel shunted field. There is no transition other than the change from full to reduced field.

(*Continued on page 537*)



First-class coach

C.P.R. Builds

Light-Weight Coaches

Unique design employs carbon steel in three classes for high-speed local train service. Passenger-carrying cars are air conditioned

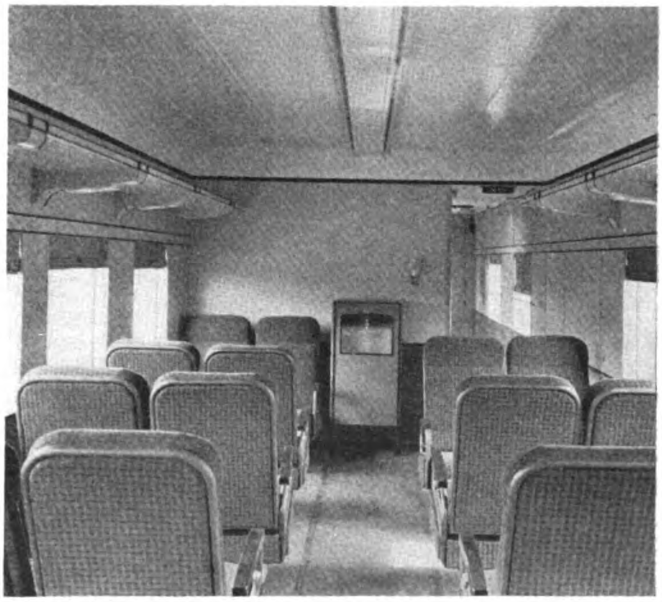
LATE last summer the Canadian Pacific completed 16 light-weight passenger-train cars of three types for use in high-speed local passenger service. There are four combination mail and express cars, four combination baggage and buffet coaches, and eight first-class coaches with large men's and women's lounges. These are assigned to four trains which will be hauled by the new high-speed steam streamline 4-4-4 locomotives delivered to the railroad by the Montreal Locomotive Works during the past summer.*

The new equipment was designed by the mechanical department of the railroad. The frames of the cars were built by the National Steel Car Company, Hamilton, Ont., and finished at the Angus shops of the Canadian Pacific at Montreal. One of the principal objectives in the design was to reduce weight. This has been done, however, by refinements in the distribution of material rather than by the employment of special alloy structural steels. With the exception of the platform end posts, which are of Man-Ten steel, the entire structure is of carbon steel. With a few exceptions, the entire structure is built by welding. The actual weights are as follows: Combination mail and express, 107,700 lb.; combination baggage and buffet coach, 114,000 lb.; first-class coach, 110,000 lb.

The Body Structure

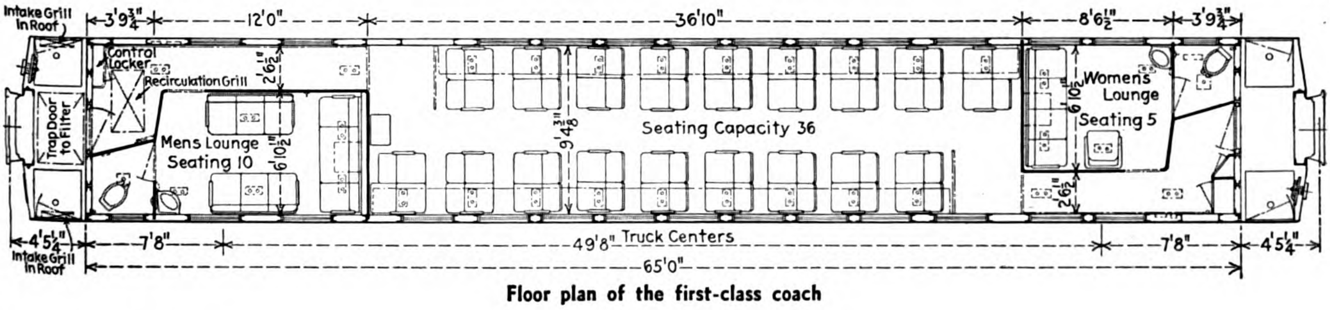
In the design of these cars the railroad has adopted a roof of oval section without clerestory and relatively flat across the top. This has been worked out on a basis to permit its universal use for new equipment, sleeping cars as well as coaches.

The body structure departs materially from the customary side and roof units in which the side-plate forms the top chord member of the side frame and the base

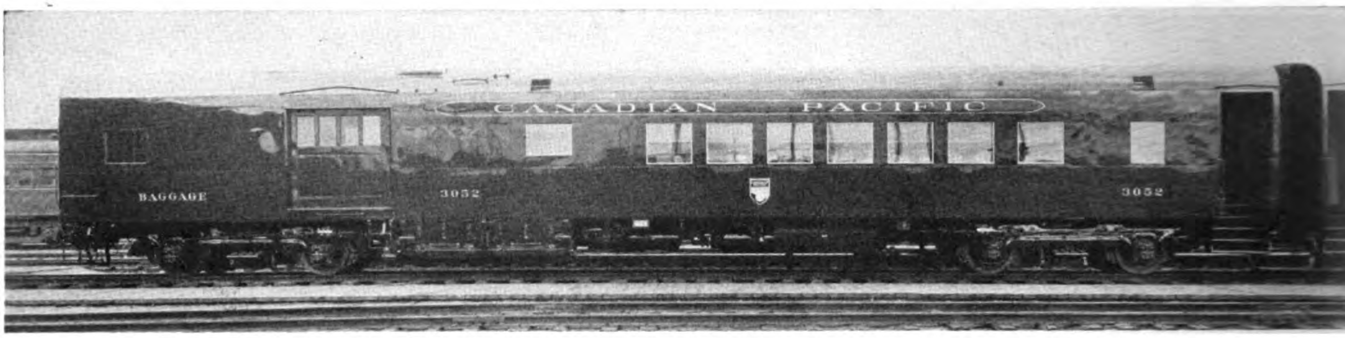


Interior of one of the first-class coaches

* These locomotives were described in the *Railway Mechanical Engineer* for November, 1936, page 473.



Floor plan of the first-class coach

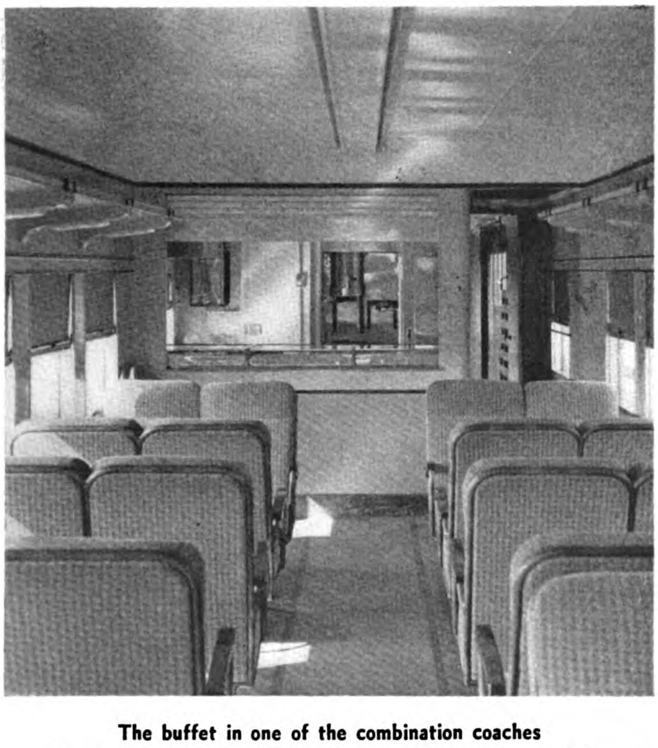


Combination baggage-buffet coach

for the attachment of the roof structure. The side posts, which are of channel section pressed from ⅛-in. steel, continue well upward into the roof curve where they are fitted into 4-in., 5.4-lb. channel longitudinal members. The carlines, which extend across the car in one piece to complete the roof frame, are likewise framed and welded to channels of the same section, and the two channels at each side are riveted together, back to back. Longitudinals are fitted and welded between the carlines, one on each side about 2 ft. from the center line.

Window-sill pressings are welded to the posts and where the outside pier-panel cover plates join the side sheathing at the window-sill level and the letter-board sheathing above the windows there is a 2-in. by 1½-in. by ⅛-in. angle welded to the posts and sheets.

Extending from the top of the letter board over the sharper portion of the curve of the roof to a point 3 ft.

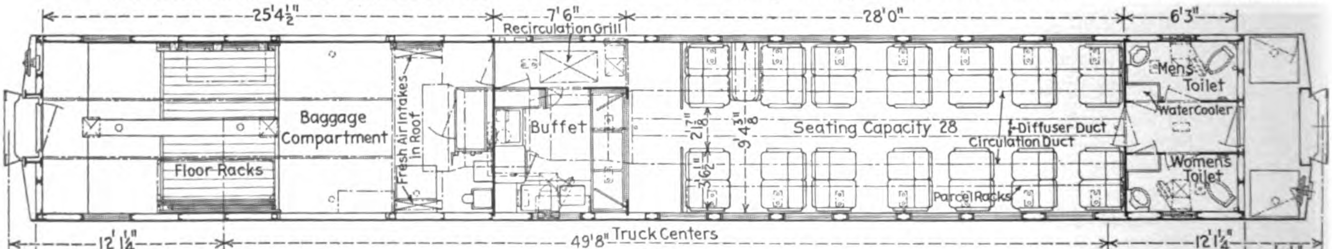


The buffet in one of the combination coaches

End equipment of the Canadian Pacific passenger cars

1½ in. from the center is a ⅛-in. roof plate which is flanged inward at the upper end between the posts and carlines, thus serving as longitudinal stiffeners at these points. It will be noted that this plate covers the joint between the side posts and carlines. The middle of the roof is covered with 1/16-in. plate which overlaps the thicker sheets at the sides.

The end structure is built up on double posts of the same section as the side posts, with 4-in. Z-bars at the corners. The platform end posts are 8-in. Man-Ten channels secured at the top by angles and gussets which are in turn fastened to an 8-in. channel end plate laid with the flanges up. The ends of the end plates are fastened to the upper chord members by means of gussets. The door posts and corner posts are fastened to the end plate by gussets and rivets. The roof end sheets



Floor plan of the combination baggage-buffet coach

Mail and express car

(⅛-in. thick) extend over the platform to the vestibule end sheet to which it is shaped and welded.

Rivets are used in the car structure on the sides of the car where the letter board and roof sheet are joined, at the joint of the pier-panel cover plate and side sheathing at the window-sill level and where the side sheathing is secured to the side sill. The use of rivets at these points was dictated primarily by considerations of appearance. Another exception from the general use of welding is the joint between the channel longitudinals at the ends of the side posts and carlines. Another is the attachment of the bolster center-brace to the sills.

It will be noted that the side posts are curved inward slightly below the window-sill level. This was done to reduce the appearance of waviness in the highly polished finished surfaces of the sides of the car.

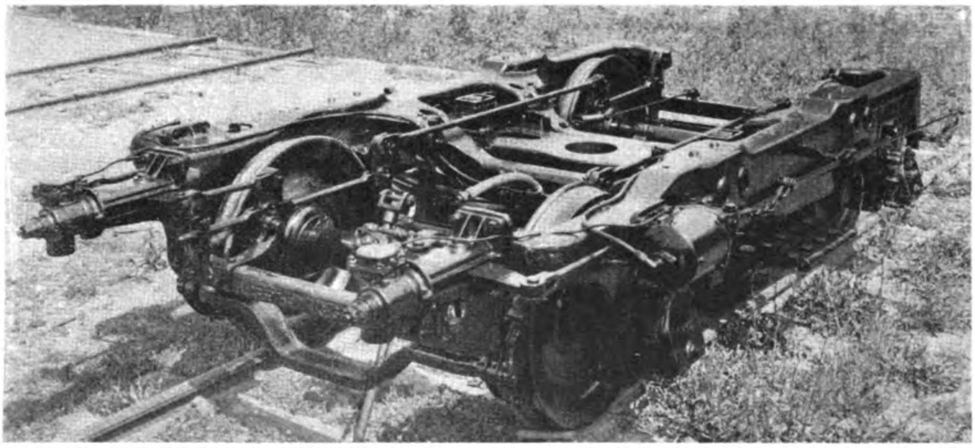
One of the interesting features of the underframe is the use of the A.A.R. standard freight-car center-sill section which has been built up by joining two 12⅞-in. by 36.1-lb. Z-section members. The bolsters are built up of 5/16-in. steel-plate webs and flanges which are joined by welding. Where the webs have been cut away the openings have been reinforced by welding on additional 5/16-in. plates. The cross-members are 5-in. 6.7-lb. channel floor beams, of which there are twenty in the length of the car. The bolsters and these floor beams, the latter of which rest upon the top of the center sills, are framed and welded to 5-in. by 3¼-in. by 5/16-in. longitudinal Z-bars at the sides of the car. The side sill is completed by welding a 2-in. by 2½-in. by 3/16-in. angle to the outward projecting bottom flange of the Z-bar, thus providing a continuous surface to which the bottom of the side sheathing is attached.

Interior Finish and Fittings

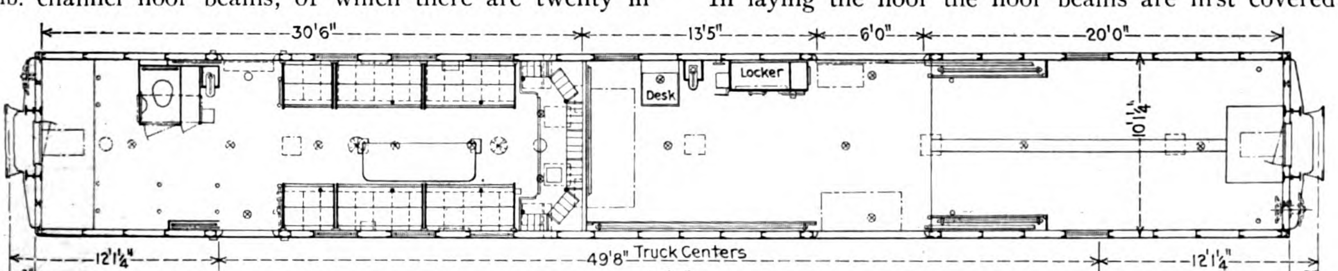
The interior of the car is finished with 5/16-in. Masonite on the side and ¼-in. Sundeala on the ceiling. The ceiling is flat for 7 ft. 6 in. between the curves by which it joins the sides of the car. In the space between the roof and the ceiling is an air duct with a cross-sectional area of 280 sq. in. with openings leading into the distribution duct below the ceiling, from which the conditioned air flows into the passenger compartments. The duct is covered with ½-in. air acoustic, outside of which is ½ in. of insulating material. Above the air duct, between the purline sections in the roof frame, 1 in. additional Salamander insulation has been inserted.

The windows are of double glass, dehydrated, permanently secured in place, and are flush on the outside.

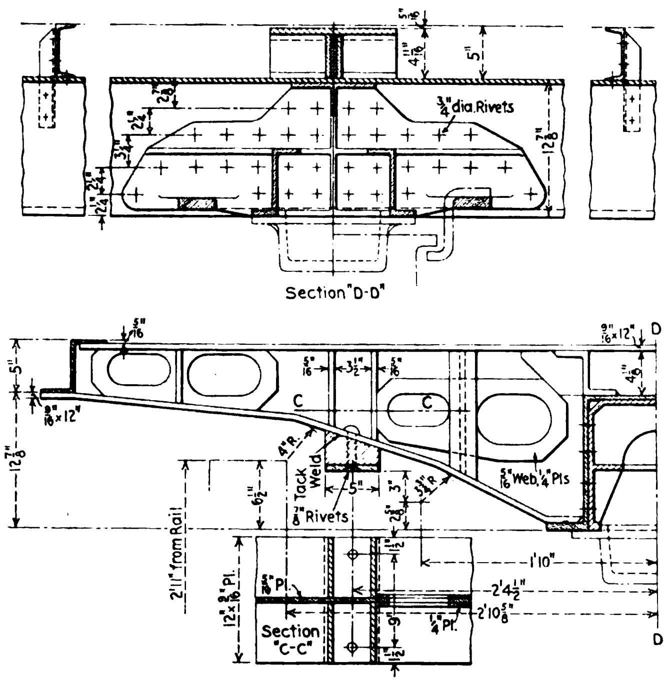
In laying the floor the floor beams are first covered



One of the trucks



Floor plan of the mail and express car



Details of the welded bolster

with pressed pans of 20-gage steel which are depressed between the beams. Next is laid the insulation which consists of ½-in. Hairinsul and ¾-in. Salamander. Above this is laid a longitudinal wood under-floor of 1¼-in. tongue-and-groove material and a transverse top floor of ⅝-in. tongue-and-groove with a layer of asphalt paper between. All floor joints are sealed with mastic. The sides and roof are insulated with 1½-in. Salamander which is placed against the outside of the car with a layer of Johns-Manville deadening felt cemented to the steel.

The ornamentation of the interior of the cars is relatively simple. Aside from the center distribution air duct, which breaks up the continuity of the ceiling, and the special aluminum basket racks, it is confined to striping between the ceiling and the side and end walls, above and below the curtain moldings over the windows and at the window-sill line.

The ceilings on both the buffet and the first-class passenger coaches are finished in light cream. The pier sections and end walls of the coach are finished in a darker cream at the top, shading down to drab at the wainscoting, which is brown. The floor is covered with marbleized brown linoleum with the aisle strip outlined by black stripes. The striping between ceiling and wall colors, over the windows and between the walls and wainscoting colors is in dark brown. The basket racks are finished in the wall color, relieved on the edges and on the brackets by black striping. The buffet coach is similarly finished, except that the walls shade down to green on the wainscoting and the floor is covered with green marbleized linoleum. The roller window shades in the coach are faced in brown; those in the buffet coach, in a green tone.

The first-class coaches are furnished with Heywood-Wakefield rotating type double seats of tubular stainless-steel frame construction, with individual reclining adjustment. Those in the buffet coach are similar, except that the backs are non-reclining. All are upholstered with Chase friezette in a checked pattern—tobacco brown in the coach and green in the buffet car.

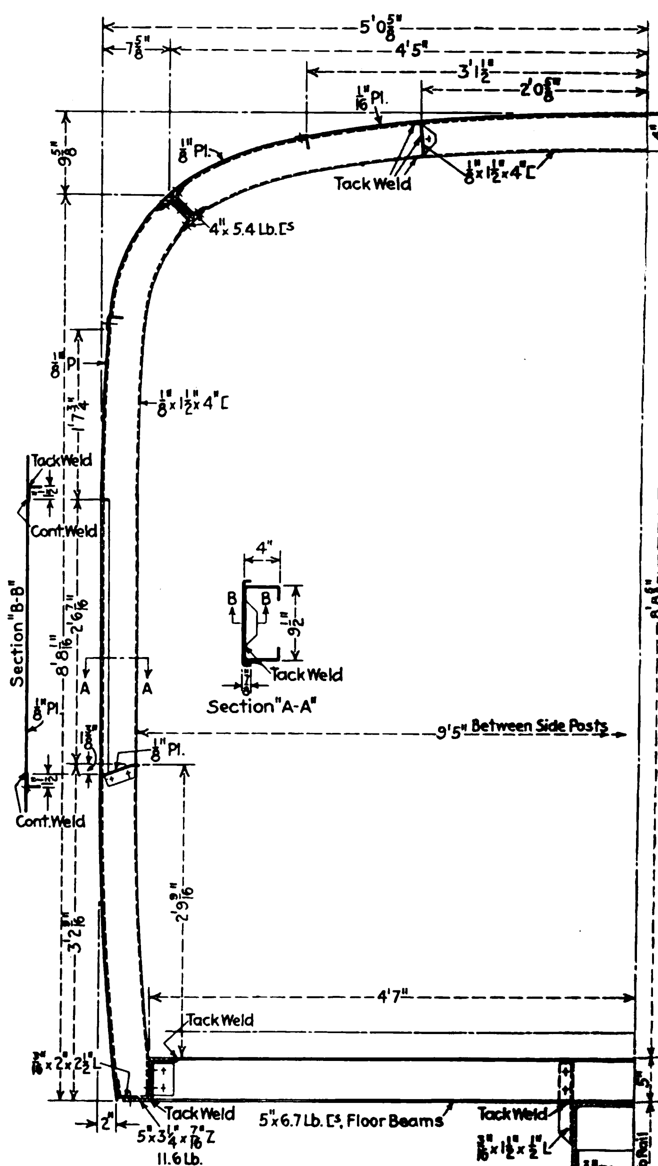
In each first-class coach is a men's lounge with a seating capacity of ten, and a women's lounge which has seats for five persons. The sofa seats in both lounges have the same angle as the seats in the coach section. Those in the men's room are in brown leather upholstery, while those in the women's room are upholstered in the same material which is used on the seats in the main room of the car. Men's and women's toilets are located in the end of each buffet coach.

With the exception of space for a side aisle, the buffet occupies 7 ft. 6 in. across the front end of the passenger compartment in the combination baggage and buffet coaches. It is equipped to serve light meals and refreshments and also provides newsstand service. Meals or refreshments can be served at the counter or at four double tables arranged between the first two pairs of seats on each side of the aisle.

The exteriors of the coaches are finished in Tuscan red, the standard Canadian Pacific coach color. The roof is in black and the name of the road is lettered in gold on a black letter-board panel which is also outlined in gold. The trucks and under body are painted black and black stripes are applied under the windows and at the bottom of the sides.

Lighting

Thirty-volt lamps are used for train lighting to insure that lamps will burn at full rated candle power from



Structural cross-section of the Canadian Pacific passenger cars

the battery when the generator is not working. With a few exceptions, the cars are lighted entirely by Safety prismatic glass fixtures placed on the underside of the baggage racks. Each fixture is equipped with two 25-watt lamps controlled by a toggle switch on each unit. This type of unit will distribute the light so that the intensity is only slightly greater over the aisle seat than over the window seat, and is designed to provide an intensity of 12 foot-candles on the 45-deg. reading plane. Similar fixtures are used in the passageways and smoking rooms, but these fixtures are not individually controlled.

Single 25-watt Safety lighting fixtures are used in the toilets. There are also 25-watt lamps in the equipment lockers and over doors and desks in the mail and baggage compartments. General illumination in the mail and baggage compartments is provided by 75-watt lamps in RLM type enameled-metal fixtures.

Air Conditioning and Heating

The combination baggage and buffet coaches and the first-class coaches are all equipped with ice-activated air-conditioning systems. Both the recirculated and outside air brought into the cars is passed through a series of water sprays. A thermostatically controlled motor-operated by-pass valve delivers water from the ice box or the sump to the sprays, depending on the amount of cooling required.

A motorized damper energized through the panel setting varies the amount of fresh air, giving 25 per cent on cooling and heating and 100 per cent on ventilation only. A large dial thermometer in the air-conditioning control locker shows outside temperature and indicates to the trainman which of three settings—high, low and medium—is to be selected to produce best air-conditioning results.

The cars are heated by the Vapor system under thermostatic control which is interlocked with the air-conditioning control. Floor heat is obtained from fin-tube radiators at the usual location and is supplemented by top heat which is distributed through the air-conditioning ducts.

Power Supply

Electric power for the coaches is supplied by 4-kw. Stone generators driven by a Stone-Cush or Hatcher drive, which consists of a split cast-steel gear mounted on the axle, driving a bronze worm. The worm is connected to the body-mounted generator through a splined shaft and automatic clutch. The clutch completely disconnects the generator from the drive when the car is running at low speeds or when it is standing. This allows for motoring of the generator, an easy inspection of the commutator, and also relieves the drive and generator from switching shocks. The clutch engages the generator at a speed of about 10 miles an hour. Drives of this type have now been in service on the Canadian Pacific for more than 600,000 miles.

Mail and express cars are equipped with Pitt drives. These consist of a split steel gear, mounted on the axle, driving the splined shaft through spur and bevel gears. These drives replace the older Stone generators in which automatic generator output regulation was obtained by slipping of the belt. This change necessitated the use of generator regulators. Lamp voltage is controlled by 75-amp. Stone lamp regulators.

The batteries on each car have a capacity of 450 amp. hr. and consist of 25 type A-12-H Edison cells.

The Trucks

The cars are equipped with four-wheel trucks having Commonwealth nickel cast-steel frames and bolsters. Those under the mail and express cars have 5½-in. by 10-in. axles with Timken roller bearings. Those under the other two type of cars have 5-in. by 9-in. axles with Fafnir roller bearings on the first-class coaches and Matco roller bearings under the combination baggage and buffet coaches. The springs are of chrome-vanadium steel. All trucks are equipped with the Simplex unit-cylinder clasp brakes with Westinghouse automatic slack adjusters.

The trucks have no center pins and are equipped with a special lock which is being used for the first time on the Canadian Pacific. The body center plate is seated in a relatively deep bolster recess and the two are locked together by retainers attached to the body bolster which hook under the flanges projecting laterally beyond the front and back sides of the bolster.

Another interesting feature of the trucks is the complete profile turning of the 36½-in. rolled-steel wheels, which are thus brought into static and dynamic balance.

Fabreeka sound-deadening material is applied to the spring planks, the transom wear plates, under the side bearings and on the pull-rod guides and cylinder-lever supports. It is also used back of the upper buffer springs and around the buffer side and center stems.

The cars are fitted with Ajax single-fold diaphragms and Miner spring buffers. The mail and express cars and the combination baggage-buffet coaches are equipped with Cardwell PF6 draft gears, while the first-class coaches are equipped with the Miner A5XB type. The draft gears are designed to go solid before the buffers so that the over-solid load is delivered on the center line of the coupler. The couplers are long-shank A.A.R. Type E with swivel butts, and are carried on pendulum type centering devices. The air-brake equipment is Westinghouse Schedule UC-4. The cars are equipped with Vapor or Barco 2-in. metallic steam-heat connectors.

Exhibition Service

Following completion, the new trains were taken on exhibition tours, amounting to a total of 7,500 miles, and during that time were visited by more than half a million people. Then, after a period of revenue service on experimental schedules, they were put on their regular runs on September 27, in each instance in relatively fast local service with a large number of stops. Two trains have been assigned to the Montreal-Quebec service which involves a 4½-hr. schedule for the 173-mile run in each direction, including 32 intermediate stops. One train, with two locomotives, has been assigned to the Toronto-Detroit run. This train has been christened "The Royal York," and will make the round trip between Detroit and Toronto daily, making the 229-mile one-way run in 5 hr. 35 min., both eastbound and westbound, with 19 intermediate stops in each direction. The fourth train, named "Chinook," will run between Calgary, Alta., and Edmonton, making a round trip daily and completing the 194-mile run in 5 hr. 15 min., with 22 intermediate stops in each direction.

Transatlantic Air Pilot Former Railway Man.—Dick Merrill, noted airplane pilot who recently took Harry Richman safely across the Atlantic and back, was a locomotive fireman for the Illinois Central at Jackson, Miss., several years before and after the World War and a locomotive engineer from 1920 to 1925. Visiting aviators at Jackson lured him away from the railroad during the latter year. His airplane service has been principally as a mail pilot on the Eastern seaboard. One of his airmail exploits was saving a farm family from a night fire by circling low enough for the noise of his motor to awaken the sleeping members.

Failures of

Locomotive Parts*

By F. H. Williams†

THERE is an old saying which aptly applies to this article, "The best laid plans of mice and men gang aft agley". The engineer in designing a locomotive is apt to overlook the fact that the finish on a part may fall far short of the standard on which he based his calculations. A highly-polished finish on a test piece gives maximum physical properties for the material tested, whereas the actual finish may be such that the physical properties are perhaps less than half of what they should be. As a result, the part fails in service, not because of poor design, but because of inferior finish.

In inspecting some finished parts which were purchased from manufacturers, the finish was found to be far from desirable. The drawings clearly indicated the kind of finish we desired, but it developed that the manufacturer's standards were on a different basis and not at all according to our ideas. A failure of a part because of this rough finish resulted in an expense of over $3,000.

If the designing engineer could see the finish of some of the parts which he designed, I am afrad he would not sleep very well. In inspecting a locomotive part I found some oil holes filled with grease and waste. Why? To protect the holes from filling with dirt? I had them cleaned out and found that they were made by drilling from both ends. They met in a weak section of the design; the center lines of the drilled holes were about the radius of the hole apart. Certainly this is not the right sort of hole through which oil could pass freely and, certainly, also, it provided a splendid starting point for a fatigue crack. What is an engineer to do when such parts fail?

One means of lubricating the large end of a main rod is to have a boss for the grease cup on the top of the rod. This boss is drilled to form the cup, with a smaller drilled hole through which the grease can pass to the crank pin. Such a design, with a proper machine tool finish, with the edges of the drilled holes rounded and with proper fillets and freedom from welds, will last indefinitely. Unfortunately, some of these factors may be overlooked and the rods fail. Fatigue cracks start from torn surfaces or tool marks, and the lack of a proper fillet or rounded edge may concentrate the stresses in such a way as to start fatigue cracks.

Sometimes a hole may be drilled too large. It is then filled in by welding and a smaller hole drilled through the welded metal. This is a questionable practice since it frequently leaves conditions favorable to the starting of fatigue cracks, as indicated in some of the illustrations.

Failures of the types above mentioned are not infrequent. We had a rod crack four months after being placed in service, because every edge of the grease cup holes was rough or burred. As a result, two deep cracks were found. Rounding the edges would have removed the burrs or roughnesses and insured a long life.

A side view of a broken main rod is shown in Fig 1. The fractured surfaces are shown in Fig. 2. It will be noted that there is a boss at the top for the grease cavity and that the bottom is weakened by the drilled and tapped hole for the stop plug. The bottom of the hole at the top had been partially filled in by the electric welding process. The break was caused by two fatigue cracks. One of these started at the electrically deposited metal in the side of the grease hole. An enlargement of this fractured section is shown in Fig. 3. The other fatigue crack was caused by an edge which had not been properly rounded off. This fractured section is shown in an enlarged photograph, Fig. 4. The break at the bottom section of the rod is of coarse structure, indicating that it was fractured suddenly, after the top section had given way, and not due to weakness in design of this bottom section. Since the boss at the top of the rod introduces complications as to machining, etc., it might be better to redesign this type of rod, leaving the boss off and using a detachable grease cup, thus corresponding to the cross section of the rod at the bottom with the stop plug hole.

The fractured section of another side rod which failed in service is shown in Fig. 5. This rod had a boss at the top for the grease cup, but there was no stop plug hole through the section at the bottom. The fatigue crack started at the edges of the grease hole, which were rough and were not properly rounded. There were no fatigue cracks in the break at the bottom; apparently it fractured suddenly after the top section had given way. Here, again, it is quite clear that while the enlargement at the top may not have been responsible for the failure, the improperly finished surfaces and edges caused a concentration of stresses, which in combination with the boss, resulted in the failure.

Still another example of a main rod which failed in service is shown in Figs. 6 and 7. In this instance there are bosses at both the top and bottom, although the lower one is smaller. It would appear that the section at the top should be much stronger than that at the bottom. As a matter of fact, fatigue cracks started at the edges of the grease hole on both sides at the top. The same thing is true, also, at the bottom, due apparently to the sharp edges of the stop plug hole.

Other examples of fractures through bosses on main rods are shown in Figs. 8 and 9. They are of special interest because in the case of Fig. 8, the progress of the fatigue cracks is so clearly shown. This is true to a certain extent also of the rod shown in Fig. 9, although here conditions are complicated somewhat by the deposit of welded metal in the hole leading from the grease cup to the crank pin. Clearly something is wrong with the design, or the workmanship, or both.

When the finish of the edges of oil or grease holes is mentioned to the average shop man, he merely smiles and

Fig. 1—Side view of broken main rod with boss for grease cup at the top. Fig. 2—Fractured surfaces of broken main rod shown in Fig. 1. Fig. 3—Enlargement of section in Fig. 2, showing nucleus of fatigue crack, that started at the edge of the metal, which was filled in by the welding process. Fig. 4—Enlargement of the section in Fig. 2, showing the progress of the fatigue crack that started from the corner, which was not properly rounded. Fig. 5—Fractured sections of another rod which failed in service because of improperly rounded corners. Fig. 6—Side view of a main rod which failed in service. Fig. 7—Fatigue cracks started at four places, as indicated, because of sharp edges.

* Part six of an article which began in the May, 1936, issue.

† Assistant test engineer, Canadian National Railways.

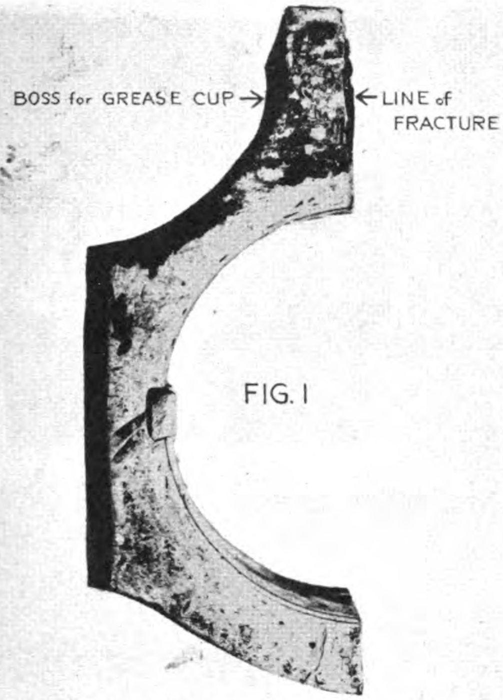


FIG. 1

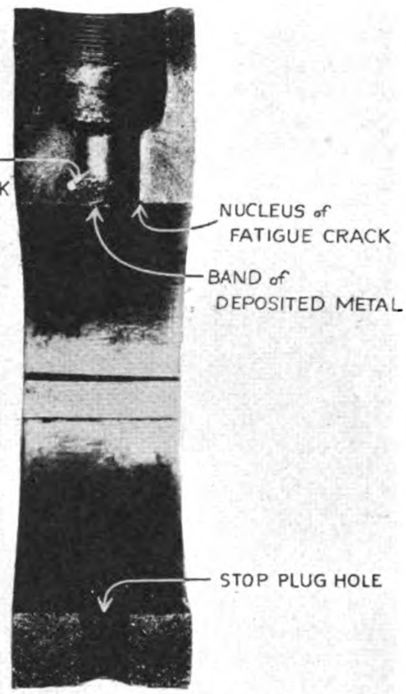


FIG. 2

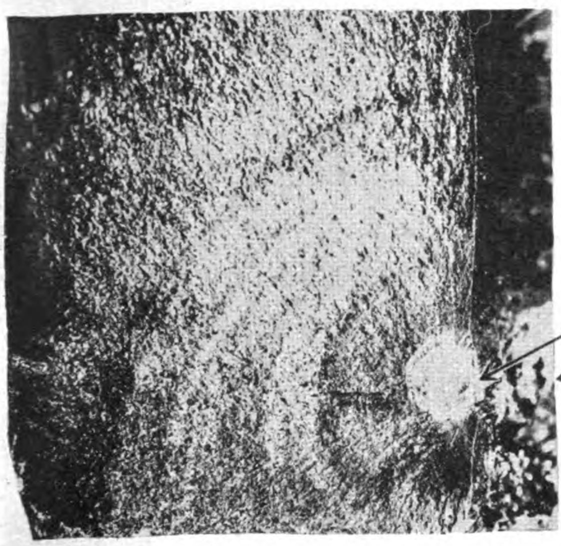


FIG. 3

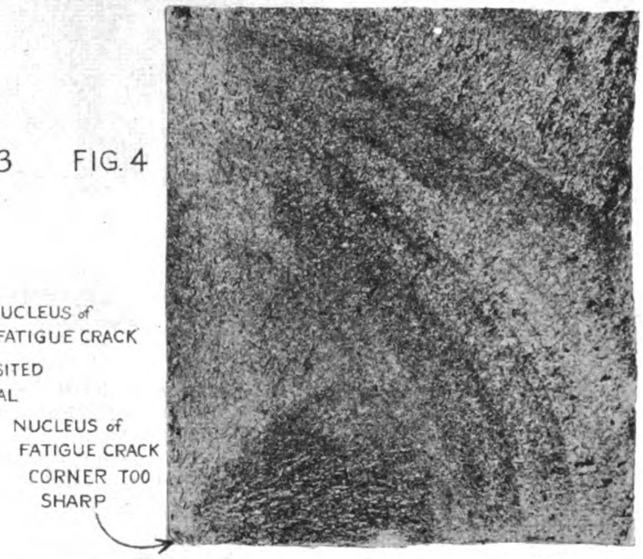


FIG. 4

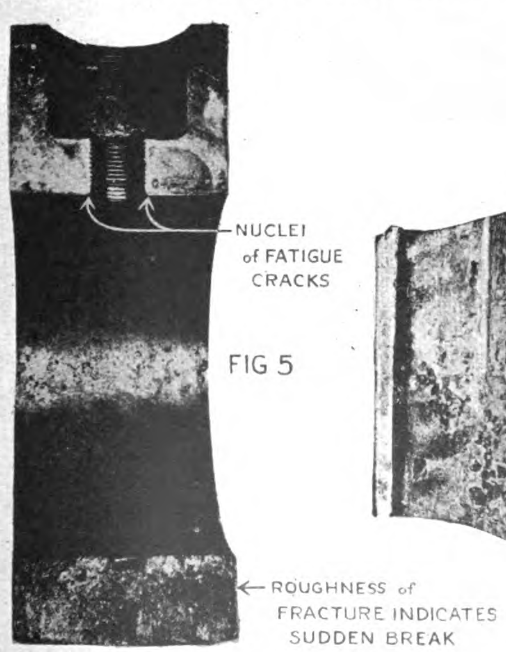


FIG 5

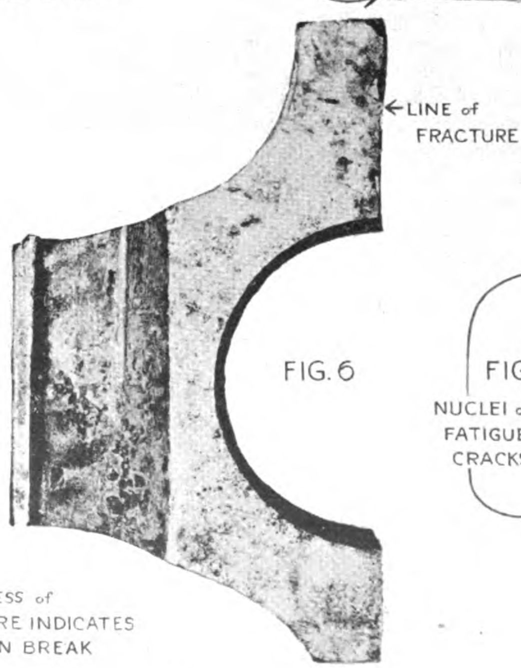


FIG. 6

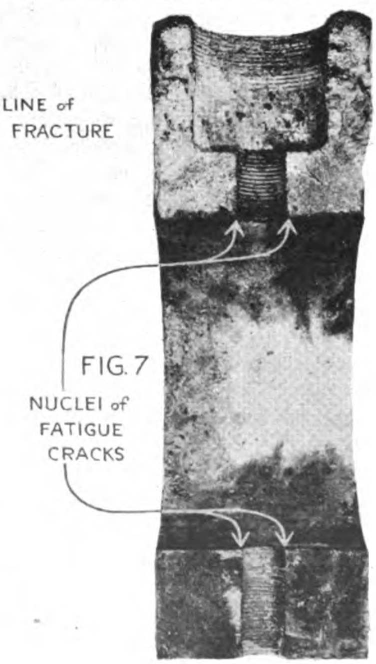
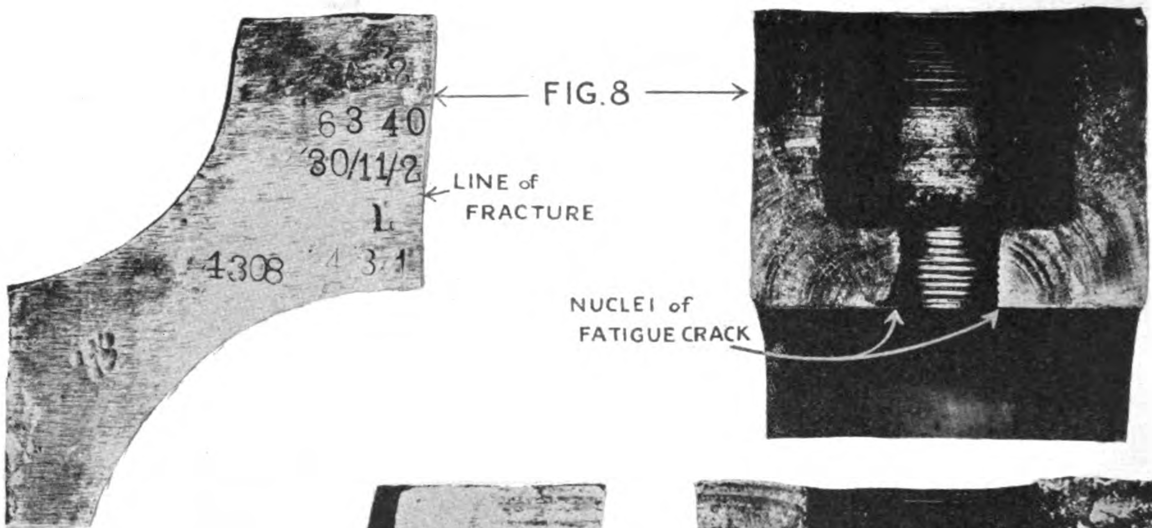


FIG. 7



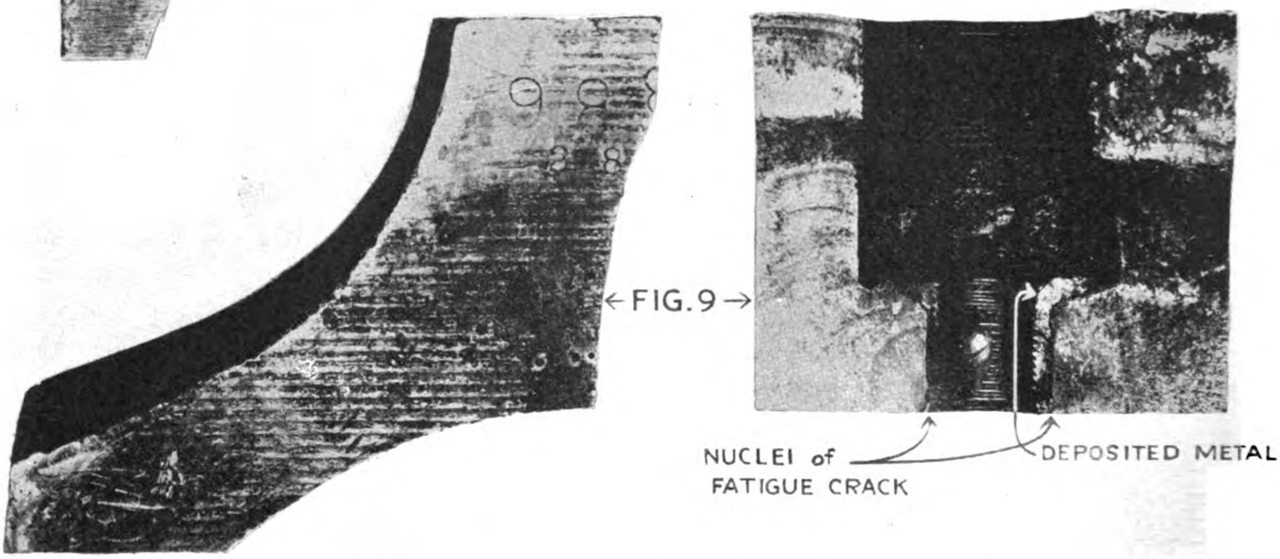


Fig. 8—The progress of the fatigue cracks is clearly shown for this main rod, which failed in service. Fig. 9—Deposited metal to fill the grease plug hole complicated conditions in this broken side rod

goes right on with his wickedness, although it is evident from the many examples of failures that neglect of this sort may lead to serious accidents.

In sending a telegram or in dispatching a train, it is the practice to repeat the message, or order, so that there may be no mistakes. It is somewhat in this spirit that I am reiterating the vital importance of having the edges of drilled holes properly finished, with suitable rounded edges, smoothly finished. This naturally eliminates coarse filing. When a side or main rod fails in a few months because of departure from this practice, it is surely time to take notice and to see that it does not occur again.

There is another feature that must be checked closely and that is the drilling of the holes. This frequently leaves the walls torn and scored. It is important that the holes be so drilled that there will be a smooth finish throughout their length.

There is a question as to whether the radii for the rounded edges should be shown in detail on the drawings and whether the finish of the walls of drilled holes should be specified in detail. I have been told that in some foreign countries the drawings do not specify these details, but that the shop practice covers them thoroughly and adequately. This seems to be a reasonable practice.

We have also to contend with the fact that the rush of repairs frequently causes the avoidance of what may appear to be unnecessary work. I recall a time when I was in charge of a change in the process of heat treating steel springs. The method was considerably slower than the one formerly used and I was continually urged to rush this or that batch of springs. I held to the well laid out plans, however, with the final result that the springs frequently stayed out for six or seven years, instead of coming back at short intervals.

The same thing is true with rods. Those which are properly finished will give a long life in service and the railroad will benefit to an enormous extent. The loss from poorly machined rods is very great and it can be cut drastically by attention to the radii of finished edges, the elimination of tool marks and score marks, and perhaps slight changes in design. The designer must bear in mind that he must eliminate possibilities of a part failing because of tool marks or unfinished edges, etc., by designing the parts as plain and simple as possible. The shop man can finish almost any shape desired, but it is not always desirable to have him do this, if it makes it possible for a thoughtless mechanic to provide causes of failure because of poor finish. Odd shapes require special care and should be avoided as much as possible. The locomotive wants plain lines of strength, and if these are used the beauty and a long, useful life will be insured.

In conclusion, let me emphasize again two facts which I have tried to bring out in this article—the necessity for the proper finish of the edges of drilled holes and the design of the parts to avoid concentration of stresses.

Locomotive Cylinder Irons Compared

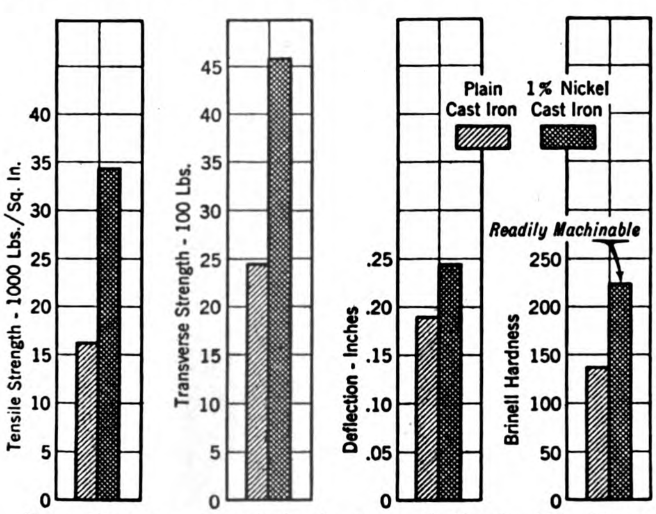
The recent production of a pair of locomotive cylinders weighing 10,000 lb. each has furnished some interesting information on the improvements obtainable from the use of small amounts of nickel in conjunction with a high grade base mixture which offers no difficulty of production in the grey iron foundry under ordinary production conditions.

In order to obtain mechanical-property data which would be more nearly comparable with the properties represented by the large slow-cooling castings, special test bars 4 in. in diameter by 18 in. long were cast in addition to the smaller arbitration type bars. In connection with the latter it should be noted that these were 1.50 in. in diameter instead of the 1.20 in. in diameter of the standard arbitration bar. The tests which furnished the data presented herewith were conducted in the Bayonne research laboratory of the International Nickel Company. The testing laboratory of the railroad in whose shops these castings were produced also conducted an investigation, the results of which are in substantial agreement with the present data. The object was to determine the relative tensile strength, transverse strength, Brinell hardness and microstructure in the 1½-in. and 4-in. sections of two types of locomotive cylinder iron as shown below:

	Plain iron	Nickel cast iron
Total carbon	3.40-3.50	2.90-3.00
Silicon	1.40-1.60	.90-1.00
Manganese	.40- .50	.85- .95
Nickel	....	1.00-1.25
Charge, per cent		
Pig iron	25	15
Car-wheel scrap	40	..
Foundry returns	35	15
Steel	..	70

The following results were secured from the tests:

1. An improvement of 100 per cent in the tensile strengths of test bars taken from the center of 4-in. rounds was found to exist in nickel cast iron as compared with the conventional grey iron. It is interesting to note that an improvement of this order in the heavy section is compared with an improvement of but 50 per cent in 1½-in. test bars representing the same two materials.



Note: All tests were made in the center of 4-in. by 14-in. bars to approximate the cooling rate in cylinders.

Physical properties of plain and nickel cast irons suitable for locomotive cylinders

2. Transverse tests on 1.25-in. diameter bars machined from the center of the 4-in. rounds substantiated the improvement in strength referred to in No. 1. As tested on 12-in. centers, the nickel cast iron showed an improvement in transverse strength of approximately 90 per cent with a 28 per cent improvement in deflection.

3. The Brinell hardness in the center of the 4-in. round-plain cast iron was found to be 137 as compared with 228 for the nickel cast iron as determined in the same relative position.

4. The microstructure of the plain iron in the 1½-in. section was found to be ferritopearlitic, as compared with a very fine pearlitic-sorbitic matrix in the nickel cast iron examined in the same section.

The core of the 4-in. diameter bar in plain cast iron displayed a coarse ferritopearlitic matrix containing free ferrite, whereas the nickel cast iron in the same section showed a very fine pearlite and some sorbite.

5. The fracture of the alloyed cast iron in the 1½-in. section was found to be mottled, but despite a Brinell hardness of 332 in this section these bars were machined without much difficulty. It should be noted that the fracture of this same material as observed in the 4-in. section was medium-grained and grey and that the Brinell hardness in this section was 228.

This difference in fracture is accounted for by the larger volume of metal and the correspondingly slower cooling rate in the heavier test bar and is more nearly representative of what might be expected in the casting itself.

New Haven Diesel Switchers

(*Continued from page 528*)

The field-shunt circuits serve a double purpose. By the selective operation of the proper field-shunting contactors, weight transfer between axles is compensated for during operation at high adhesion. In other words, the field of the motor on the leading axle of each truck is shunted, thereby reducing the tractive force on that axle approximately in proportion to the amount of weight relieved. This allows all four axles to operate at the same adhesion even though their loads are different, and thereby advantage is taken of the entire weight of the locomotive, and not the weight as limited to about four times the load on the lightest axle under severe weight-transfer conditions. Weight-transfer compensation is obtained by operation of a foot pedal at the engineer's position and is used under much the same conditions as sand. By its use the effective weight of the locomotive is increased about 10 per cent.

As a further aid to rapid switching, slip relays are installed which operate a buzzer at the engineman's position when slipping occurs, giving him instant warning that he has lost the tractive force on one truck or both.

Auxiliaries

The main generator also furnishes power for all auxiliaries. At idling speed, 300 r.p.m. with the throttle in the off position, the main generator voltage is regulated at 115 v. by a voltage-control relay. When the throttle is open, the generator continues to operate the compressor and radiator blower, but the battery charge is dropped and the battery furnishes power for control and lights.

The compressor is a high-speed, single-stage, water-cooled machine with a displacement of 100 cu. ft. per min. It is driven by a double-commutator motor for

operation at full displacement at 115 v. during idling, and at full displacement at 600 v. when the generator is furnishing traction power.

Provisions were made for heating the locomotives in cold weather from an external steam supply when the Diesel engine is shut down. Keeping the engine from freezing is always a troublesome problem during layovers. The New Haven switchers, therefore, were equipped with a 2-in. insulated steam line with standard hose and coupler head at each end, so that they can be connected either to yard steam supply or to a steam locomotive, and the engine jacket, radiators, piping, etc., kept warm.

The generator is isolated from the engine compartment by a partition, the generator fan discharging on the engine side of this partition. Thus the generator draws cool air in over the control equipment and discharges it into the engine room, putting the engine room under pressure to assist in its ventilation. The air intake of the engine is taken almost directly at the louvers in the hood doors so as to provide the coolest air possible.

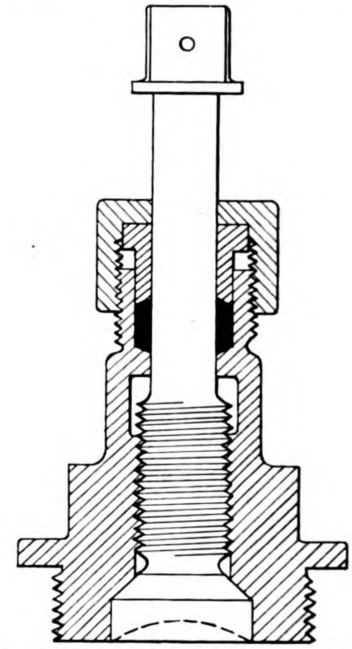
Up to the middle of October three locomotives had been delivered to the railroad and immediately prepared for and put into regular 24-hour service in New Haven. Preliminary plans call for the assignment of three locomotives in New Haven, two in Providence and five in Boston.

Improved Boiler Check Valve

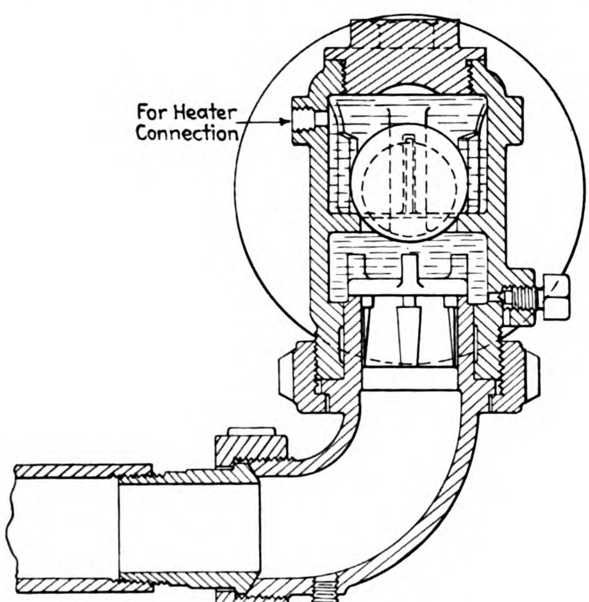
A combination ball-and-stop boiler check valve, recently placed on the market by the Morris B. Brewster Co., Chicago, employs a stainless-steel ball in the upper or pressure cavity of the body for retaining boiler pressure therein to permit the removal of the stop check valve for reseating, when necessary, without blowing down the boiler.

The ball, being nearer to the source of pressure, takes its seat when the flow of intake boiler feed water ceases, an instant prior to the stop check valve. The stop check valve, in turn, seats against the receding branch pipe water as a cushion with a resultant reduction in pounding effect and frequency of reseating.

The ball rotates, when unseated during the intake of boiler feed water, in monel-metal guides cast integral with the upper cavity of the check body, and this rotary action maintains the ball in a scoured condition which assures dependable seating at all times. The lift of the stop check valve is governed by the length of the projections on its top surface which may be reduced to provide increased lift if necessary.



Clamping screw for seating the ball when testing a feed pump



Brewster combination ball-and-stop boiler check valve

This boiler check is designed with either threaded spanner nut or bolted flange connections to the branch pipe and for either single-side or twin-top boiler applications for use with an injector or a boiler feed pump system. When used with a boiler feed-pump system, a cap with a clamping screw is provided for seating the ball when a slip test of the feed pump is being made.

* * *

Canadian National 4-8-4 type locomotive

EDITORIALS

Attention Please!

With the completion of the December issue of the *Railway Mechanical Engineer* the final work on the index for the calendar year is begun. The index is mailed only to those who desire it. If you did not receive the 1935 index, please send us promptly your name and address for inclusion on the 1936 mailing list. A subscriber having requested the index for 1935 will receive it again this year without further attention.

Equipment Orders

The number of orders placed for cars and locomotives for domestic use during October was most gratifying, as was pointed out in the editorial on Car and Locomotive Orders in our November number. The record for the first 27 days of November, however, proved to be much better, two good sized orders being announced the day before Thanksgiving. Orders reported for the first 27 days of November included 193 locomotives, 2,550 freight cars, 42 passenger cars and six light-weight passenger trains with an aggregate of 20 body units. This brings the total orders for domestic use, for the first eleven months of 1936, except for the last few days of November, to 373 locomotives, 41,214 freight cars, 204 passenger cars and 10 light-weight passenger trains with an aggregate of 52 body units either partially or wholly articulated.

Equipment Ordered for Domestic Use

	Locomotives	Freight Cars	Passenger Cars
1925-9 (inc.), Average	981	78,854	1,980
1930	440	46,360	667
1931	176	10,880	11
1932	12	1,968	39
1933	42	1,685	6
1934	183*	24,611	388†
1935	83	18,699	63
1936 (to Nov. 27 only)	373	41,214	204‡

* 73 of these were electric locomotives for the Pennsylvania.
† 113 of these coaches were for the Erie and 50 for the New Haven.
‡ To this must be added 52 body units in 10 light weight articulated trains.

There were inquiries outstanding on November 27 for 72 locomotives, 11,031 freight cars and 36 passenger cars. There is, therefore, a possibility that before the end of the year total orders for locomotives and freight cars may equal or exceed those for the year 1930. Car loadings have continued to hold up well and general business conditions are such that it is quite likely that unless something unforeseen happens, the traffic for the year 1937 will greatly exceed that for the present year.

An Outstanding Performance

A passenger-train performance was recorded on the London & North Eastern Railway of England on August 27 which is both outstanding in character and illuminating in relation to the light-weight, high-speed trains which have been attracting so much attention in America. The performance was recorded on a regular run of the "Silver Jubilee" train operating between London and New Castle, a distance of 268.3 miles, on an overall schedule of 67.07 miles an hour with one intermediate stop. The run was made with the regular train of seven body units, articulated in two groups of two and one group of three units each, weighing 246.4 (short) tons, with a dynamometer car which brought the train weight up to 284.5 tons. The train was hauled by the "Silver Link," a streamline Pacific type locomotive, with a total weight, including tender, of 185.2 tons, bringing the entire weight of train and locomotive up to 469.7 tons.

On the opposite run on the same day a maximum speed of 113 miles an hour was recorded on a descending grade. During the performance under consideration, however, the top speed was limited to 90 miles an hour and all operating slowdowns were strictly observed to determine what reserve the locomotive might have on the schedule. The record of the run, presented in the Railway Gazette (London), deals with the non-stop portion from Kings Cross to Darlington, 232.3 miles, made on a schedule of 198 min., or 70.4 miles an hour. This was actually timed on the day in question at 194 min. 43 sec., or 71.48 miles an hour.

The trend of the road is essentially level, there being no significant difference in elevation between the two termini. There are, however, two major summits with ascending grades at the prevailing rate of 0.5 per cent for approximately eight miles and nine miles, respectively, with a number of lesser summits with similar grades two or three miles long. The remainder of the line is gently rolling or level.

Except for periods of acceleration at the beginning of the trip and following a number of operating slowdowns, the locomotive worked steadily at a cut-off of 18 per cent, including the ascent of the longer of the two hills, which was made without change of cut-off with a reduction of speed from 86½ miles an hour to 75 miles an hour in 11 miles, of which five ascended at the rate of 0.5 per cent and three 0.56 per cent. One of the remarkable features of the locomotive performance was the small drop in pressure between the boiler and the steam chest. During much of the time the locomotive was operating with full throttle the pressure drop was

limited to 5 lb., with occasional increases to 10, 15 and 20 lb. For an appreciable part of the run on the descending grades the locomotive was operated with the throttle partially closed.

The Silver Link is a three-cylinder locomotive carrying a boiler pressure of 250 lb. and developing a tractive force of 35,455 lb. on 80-in. drivers. It has a combined heating surface of 3,326 sq. ft. and a grate area of 41.25 sq. ft. Estimating the indicated horsepower capacity of the locomotive at high speeds conservatively, this train, as operated during the test, had a horsepower-weight ratio of slightly less than 5 hp. per (short) ton of combined locomotive and train weight and a ratio of five or better per ton when hauling the normal train.

The Denver Zepyhr trains recently placed in service by the Chicago, Burlington & Quincy consist of ten body units, three of which are independent vehicles and seven of which are articulated in three groups of three, two and two units, respectively. The trains weigh 415½ tons each and are hauled by a two-unit Diesel-electric locomotive weighing 213 tons, a total of 628.5 tons. The 3,000 hp. of rated engine capacity provides a horsepower-weight ratio of 4.7 hp. per ton of combined train and locomotive weight.

This train operates on a schedule of 16 hours for 1,017 miles, an average, including ten intermediate stops, of 63.56 miles an hour. The character of the two runs is so different that direct comparisons are impossible. Both, however, have two characteristics in common. They require fast running, and their ability to maintain such schedules lies in a high horsepower-weight ratio, not primarily in the kind of motive power with which they are hauled.

Handle Small Tools Carefully

Experienced railway shop men generally appreciate that small cutting tools, such as milling cutters, reamers, taps, etc., with exposed cutting edges, must be handled carefully if the desired results in the way of smooth, accurate high-production work are to be obtained. In other words, the tools may be correctly designed and ground in the first place, but unless the cutting edges are guarded against subsequent damage throughout the entire period of shop and tool room handling, they are almost sure to become dulled, nicked, or broken with resultant inferior work, power wasted and time lost.

The unfortunate fact about cutting-tool efficiency is that it may be lost by momentary carelessness on the part of shop men, who, generally speaking, are good mechanics but who have allowed their vigilance to relax in a brief period of thoughtlessness, or just enough to permit tool damage to occur. The result it that all of their good work in being careful nine-tenths of the time is lost.

Many instances may be cited to show the way in which even a careful program for the handling of small tools may be rendered largely ineffective by slighting a single detail. In one shop, for example, the tool foreman took a justifiable pride in his toolroom with its modern equipment and well-designed bins where cutting tools could be kept safely and in an orderly arrangement. He even went so far as to line the bins in the tap section with felt to protect the cutting edges of the tools. Much to the chagrin of the foreman who made a surprise check one day, he found taps stacked two and three deep in some of the bins! Needless to say, many were nicked. A further check in the shop showed numerous instances in which machinists tossed individual taps carelessly onto metal-top benches or into metal-lined tool boxes, etc.

Milling cutters of the larger size are usually handled fairly carefully owing to their weight, but small cutters and especially reamers frequently receive even less considerate treatment than taps. An article in the March *Railway Mechanical Engineer,* page 121, showed how one large midwestern railway shop used expensive ring gages to check the accuracy of reamer taper after grinding and also provided individual rubber protective boots for the larger frame reamers to avoid the possibility of damage while handling them about the shop. These boots consisted simply of scrap air-brake hose, cut to the proper length and provided with a wooden block in one end, held in place by three or four short nails. By the enforcement of rather rigid instructions requiring that reamers be kept in these protective boots at all times while out in the shop, except when actually being used for reaming holes, much more satisfactory reamer conditions and performance were attained.

One other fact regarding cutting-tool condition should be kept in mind; namely, that while the results of careless handling and resultant tool damage can be corrected by frequent grinding, cutting-tool life is thereby proportionately reduced. It is obviously good economy to exercise constantly the greatest care practicable in handling all types of cutting-tools used in railway shops.

Re-Winning Public Opinion

Alfred P. Sloan, Jr., president of the General Motors Corporation, gave a luncheon in New York on November 10 for Charles F. Kettering, in commemoration of the twenty-fifth anniversary of his invention of the electric self-starter for automobiles. During the course of the luncheon W. Averell Harriman, chairman of the Union Pacific, was called upon to speak for the railroads. Mr. Harriman naturally referred to the fact that early in the century the Union Pacific led the way in the application of the first internal combustion engine to a rail motor car. The first one of these cars, designed and built under the direction of W. R. McKeen, Jr., superintendent motive power of the Union Pacific, was placed in service April, 1905, and was described in the August, 1905, number of this publication, which was then known as the *American*

Engineer and Railroad Journal. A considerable number of these cars were built and placed in service.

Mr. Harriman went on to say: "We had our engineers abroad, studying all through the 20's the progress of the Diesel engine, but we did not feel that it was reliable enough or the economies justified the expense of experimentation, until we realized that public opinion was at stake and there was not any amount of money that we could not afford to spend to regain that."

There is no doubt but what the dramatic introduction of the streamlined trains has been a tremendous factor in attracting favorable public attention to the railroads. The public has regarded this innovation as evidence that the railroads still have a lot of fight in them and are determined to regain passenger traffic which was lost to their competitors. Passenger trains, whether streamlined or not, have been speeded up throughout the country and an increasing amount of attention has been given to making all trains more comfortable and convenient.

Mr. Harriman's final point, however, was a bit unusual and drives home a truth that we have systematically tried to emphasize in these columns, and that is that mechanical department employees, although they do not normally come in intimate contact with the traveling public, have an important responsibility in establishing better relations with the public. "Now it would seem rather odd when we are thinking about engineering," said Mr. Harriman, "I am talking about public opinion, but I think it would be a darned good thing if you engineers would put your minds to work on the job for industry to rewin public opinion."

The public is greatly and favorably impressed with the improvements that have been made in railway equipment and in the speeding up of the services. It will not be content, however, unless the job is fully and well done. A public which is shown all sorts of little courtesies by those who serve it in various capacities will not be satisfied with a few first-class trains, which are fitted with the latest conveniences and are decorated in an attractive maner. A favorable public opinion is vital to the railroads and its continuance can only be insured when the railroads extend the best of services and courtesies to the passengers on all trains, as well as to shippers generally. The mechanical department, because it designs and maintains the equipment, has a large responsibility in this effort.

NEW BOOKS

HANDBOOK OF ENGINEERING FUNDAMENTALS. *Prepared by a staff of specialists under the editorship of Ovid W. Eshbach. Published by John Wiley & Sons, Inc., New York. 1,081 pages, 5½ in. by 8⅜ in., illustrated. Price, $5.*

The "Eshbach" handbook is the first volume in a proposed new Wiley Engineering Handbook Series. It has been prepared for the purpose of embodying in a single volume those fundamental laws and theories of science which are basic to engineering practice and is essentially a summary of the principles of mathematics, physics and chemistry, the properties and uses of engineering materials, the mechanics of solids and fluids and the commonly used mathematical and physical tables, to which has been added a discussion of the elementary legal aspects of contractual relations with which all engineers should be familiar. The thirteen sections of the book cover Mathematical and Physical Tables; Mathematics; Physical Units and Standards; Theoretical Mechanics; Mechanics of Materials; Mechanics of Fluids; Engineering Thermodynamics; Electricity and Magnetism; Radiation and Light Acoustics, and Meteorology; Chemistry; Metallic Materials; Non-Metallic Materials, and Contracts.

KENT'S MECHANICAL ENGINEERS' HANDBOOK—POWER. *Published by John Wiley & Sons, Inc., New York. 1,254 pages, illustrated; 5⅝ in. by 8⅝ in. Price, $5.*

Kent's Handbook, in two volumes, of which "Power" is the first, is the second of the revised Wiley Engineering Handbook Series. The second volume, "Design and Shop Practice," will not appear until next spring. "Power" deals with the entire field of power and its application. It is divided into 17 sections. Section I, Air, includes not only a description of the properties of air, but also a discussion of the flow of air and a full treatment of air-compression, including fans and blowers. Section II, Water, covers the fundamentals of hydraulics. Section III, Heat, treats of the measurement of heat, heat transmission, evaporators and evaporation, dryers and drying, heat insulation and thermodynamics. A section on Combustion and Fuels follows. Section V gives information concerning steam, with extensive data as to its properties, steam piping and steam valves. Section VI applies these principles of the action of steam to the steam boiler, describing the various types of steam boilers, their performance, construction, etc., as well as superheaters, economizers and air heaters, moisture in steam, feedwater for steam boilers, boiler furnaces, and chimneys and draft. Section VII discusses the Steam Engine, while Section VIII covers the types, performance, etc., of the steam turbine. Section IX deals with Condensing and Cooling Equipment, and Section X with Refrigeration and Ice Making. Section XI presents a summary of the essential information in the field of Heating, Ventilating and Air-Conditioning. Internal Combustion Engines, including Diesel, gas and gasoline engines, are given much space in Section XII and Gas Producers in Section XIII. The needs of the mechanical engineer in railroad engineering, automotive vehicles and aeronautics are covered in Section XIV. Section XV summarizes the fundamentals of Electric Power. Power Test Codes are discussed in Section XVI and Section XVII contains mathematical tables of importance to the mechanical engineer.

THE READER'S PAGE

No Grouchy Railroad Employees?

To the Editor:

I have been on the look-out for a long time for something I can disagree with, or at least question in the columns of the *Railway Mechanical Engineer*—not for any special reason, but perhaps because I believe it is impossible for any publication always to be 100 per cent.

I think I have found it at last. On page 399 of your September number, your otherwise very interesting and timely editorial states that one is constantly confronted with criticisms of grouchy railroad employees. Surely you have been referring to the notes you made years ago in your travels around the country, and I just want to give you an opportunity to correct your statement or bring on some proof. I am speaking for the Canadian National Railway and believe such a condition does not exist on this railroad. Come on now, where are the grouches located?

Harry Westbrook

(Cases of grouchy railroad employees are not hard to find, even in these days. It would be embarrassing to have to mention names and places. It is true that some railroads have gone a long way toward impressing their employees with the necessity for courtesy and friendliness. Experiences within recent months, however, and correspondence which is coming to our desk, indicate that many railroad employees are almost entirely lacking in an understanding of the importance of courtesy and friendliness in contacting with the traveling public. —Editor.)

Carrying Scrap In the Storehouse

To the Editor:

Since 1929 large numbers of cars have been retired. The majority of this equipment has been dismantled by contractors who sell back to the railroads whatever material they wish.

Generally the stores departments of the railroads furnish the contractors lists showing what items they want. The stores departments place this material in stock without knowing whether or not they are buying good material or scrap material. Then, when the mechanical department issues a requisition for some of it, in many cases it is found that, according to A. A. R. rules and specifications, the items furnished should be scrapped. Items such as truck springs, brake beams, couplers, cast-steel truck side frames and many others are either scrap or have to be repaired. The repairs to these items will cost more than it would cost to purchase them new from the manufacturer. Besides, there is the delay in getting out the cars, etc.

On the majority of the railroads you can see large piles of coupler knuckles purchased from this source. A good many of them should not have been purchased and would not have been had the proper gages been used before they were removed from the couplers. If the proper gaging and inspection were made when such materials are purchased, the railroads would not be carrying a lot of scrap material in stock.

W. H. Shiver.

Take It On the Chin

To the Editor:

Like many other roundhouse foremen, I have come to regard the *Railway Mechanical Engineer* as something to look forward to each month. The interesting letter, or article, by "Bill Brown" several years ago, brought the foreman's job very much to the front.

From time to time, we read articles in the magazine by supervisors; some lament the fate of the roundhouse foreman and set forth changed conditions, running through terminals, and a host of other reasons for the foreman's so-called hard times. Again, others give us a picture which shows up very much in contrast. They have time to attend to lodge work, and other social functions. Occasionally they enter the House of God.

Just what does the outsider, or perhaps the chief supervisor, think of these opposites. Frankly, were I a chief of motive power, looking over the pages of the *Railway Mechanical Engineer,* I would wonder whether or not some of these men were "whiners" and others "cheerful, hustling, good, common-sense foremen."

True it is that conditions have changed. The stage coach passed, giving way to the "iron horse." Before me, as I write, is a part of a sermon preached by a certain Divine about a century ago, calling down the wrath of the Almighty on those who rode the "smoke belching, roaring contraptions," as he called the steam engines of George Stephenson's day.

Progress was not stayed by such diatribes. Time marched on, and ever will. We foremen must accustom ourselves to the ever-changing conditions. The writer, after almost 30 years connection with the "iron horse," and its activities, looks back upon these years as a panorama of progress. A ranking officer once remarked, "we cannot put 50 year heads on 25 year old shoulders, it is experience that counts." True, and that experience has covered many fields with any foreman who has had the benefit of many years experience, as instance:

The great increase in size and hauling capacity of our locomotives. Streamlining, and also the Diesel and oil-electric engines. Improved methods of effecting repairs and modern types of machinery. The electric and oxy-acetylene methods of welding. Systematic methods of following up failures to determine the cause, with a view to education and avoiding repetition. Education on accident prevention, from which excellent results have been obtained on our railway systems. The shortening of hours of service, and general improved working conditions, not to mention a hundred and one laws, rules and regulations, all pointing in the direction of education, safety, and good railroading.

We foremen should endeavor to keep up to scratch. After all, it is our job and we are a cog in the wheel of the great system we serve.

The test of the man is the fight he makes
  And the grit that he daily shows;
In the way that he stands on his feet and takes
  Life's numerous biffs and blows.

A coward can laugh when there's nothing to fear
  And everything goes like a song;
But it takes a man to stand up and cheer
  When the whole blamed works goes wrong.

Another Roundhouse Foreman.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Eliminate All Tool Marks

Since more attention has been given the proper machining of parts we have noticed longer life with better results. A campaign is being made to eliminate all tool marks from machined surfaces and, wherever possible, ground fits are being made.

Better Be on the Right Side

I have read wth interest most of Mr. Williams' articles and believe that the points he brings out are generally very well taken. I think that some of the consequences he points out are probably somewhat exaggerated. However, it is of course always better to be on the side of extreme carefulness rather than carlessness in finishing locomotive parts, and not leave tool marks which may later result in failures.

Tricks of the Trade

With seniority ranking in locomotive shops today, mechanics do not move around as in the days of boomer journeymen, who carried from shop to shop the latest ideas and methods. We apprentices are taught but one method per operation, and only from the old timers or some trade publication may we learn of the dozen different methods in use at other points and of the tricks and short cuts employed.

Hardly Scratched the Surface

The information furnished by Mr. Williams in his articles on Failures of Lccomotive Parts is of great interest to all railroad men. However, he has hardly scratched the surface. We have been following the practices referred to by Mr. Williams for quite a while, and have even gone further, with the result we have avoided many failures of locomotive parts, which has naturally reduced the number of engine failures and delay to trains.

Links in a Chain

If I might say so, I should like to see kept out of the *Railway Mechanical Engineer* all such articles as those by correspondents dealing with whose department is of the greatest importance. I think such stuff very childish and in poor taste. Let us fully appreciate the importance of the other fellow's job—we are all links in the chain. Let us learn from each other, not knock each other.

Williams' Articles Thought-Provoking

Mr. Williams' articles have the one excellent feature of being thought-provoking. Smooth and bright finishes are naturally desirable, but the question comes as to the cost and practicability of obtaining them. It is one thing to point out that rough machining leads to failures, but it is another thing to figure out just how much you are warranted in spending in eliminating rough machining. Such a problem can only be answered by real research. That is the kind that is thorough and costs time and money. It seems to me that such work is well worth while and inasmuch as all railroads would benefit, it is a matter for considered action.

Heating Passenger Trains

The subject of steam heat on passenger trains needs to be dragged out into the open and treated rather mercilessly. How much steam is required to heat, let us say, a standard 12-section Pullman sleeping car, standing still in zero weather? At 60 miles per hour? At 80 miles per hour? What is the pressure drop from the locomotive to the rear car under the same conditions? This problem involves certain fundamentals which are not necessarily tied up with specialized equipment of a competitive character.

Can't Be Too Careful in Checking Up

The articles written by F. H. Williams are very interesting and show conclusively that unless we are pretty well versed in failures of this kind we should not pass judgment on the cause of the failure. As far as we are concerned, in the turning and finishing of tires, I believe the practice at the shops is proper. We carry out the writer's suggestion and forward the broken parts to the laboratory for proper examination by those who are well fitted to do this examining; in making reports of failures of this kind, it is very important that all details be covered.

Administrative Ability Does Count

I read the article, "So You'd Rather Be a Puritan?" and re-read the "Roundhouse Foreman's Daily Log," and found them very interesting. While I realize that a roundhouse foreman at times comes up against a set of conditions that is difficult to overcome, I think that the gentleman who wrote these articles must be better at writing for magazines than at handling a roundhouse. A good roundhouse man must possess, among other things, mechanical ability, mechanical experience, executive ability, and authority. If he had these, I don't believe there would be many occasions on which he would have to cope with as many obstacles as does the gentleman who wrote the "Roundhouse Foreman's Daily Log."

Tire Failures

I have read Mr. Williams' articles on Locomotive Failures with a good deal of interest. With the increased speed, tire failures have become more numerous and frequently no good reason has been in evidence as a cause of the failures. If better and smoother boring of the tires will have a tendency to guard against such failures, and I have good reason to believe it will, then a good deal has been accomplished by Mr. Williams' research. We have all learned in later years to appreciate the hazard of sharp corners and scratches on machined parts, and as we go along the fruits of better shop practices should register an improved service, which, after all, is what we are all striving for.

Suggestions for Walt Wyre

I get quite a kick out of the Walt Wyre stories and the discussions on the Reader's Page about the foreman.****Getting back to Walt Wyre, I believe not enough is being done in his stories relating to the primary causes of engine and car failures and the proper methods of overcoming them. In other words, would it not be a good idea for him to write his stories so as to be most instructive to the younger railroader, by giving him the benefit of experience? I read an article about a throttle which leaked badly after being ground in. This operation was repeated several times without stopping the steam leak. Eventually it was found that the throttle box had been cast thin on one side and that expansion caused it to warp, resulting in the leakage. I like to read such articles because they are instructive.

Quantity Production of Piston Packing Rings

The Dunbar type of sectional packing ring is used generally for locomotive cylinder packing on the New York Central System and the production of these rings has been concentrated at the West Albany, N. Y., shop.

Description of the Ring

Fig. 1 shows the details of the Dunbar type ring. It is a sectional ring consisting essentially of an outside ring rectangular, in cross section, an inside ring of L-shaped cross-section and a tempered alloy-steel spring expander used in the grooves of the piston under the ring.

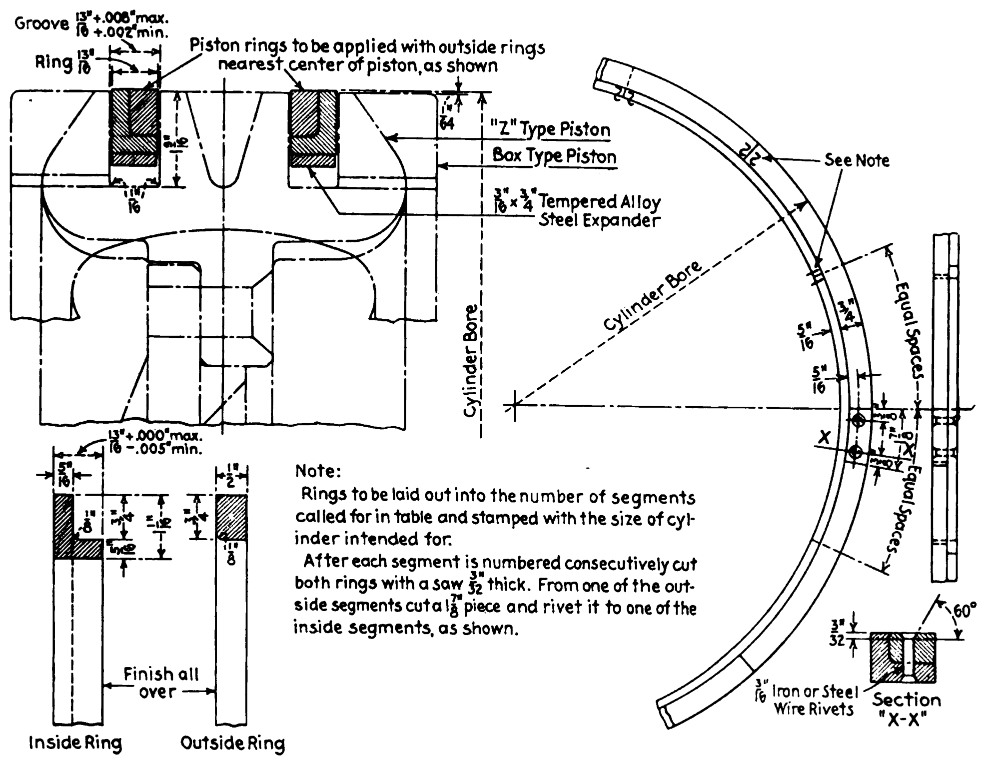


Fig. 1—Details of Dunbar type ring

The table referred to in the note above appears on the railroad company's original drawing and includes the dimensions of the various sizes of rings for all locomotives

These rings are used for cylinder diameters varying from 19 in. to 40½ in. As indicated in the drawing the rings are in segments, the number of segments varying as follows:

Cylinder diameter from 19 to 22½ in.	6 segments
Cylinder diameter from 23 to 27 in.	7 segments
Cylinder diameter from 27 to 28½ in.	8 segments
Cylinder diameter from 34 to 34½ in.	9 segments
Cylinder diameter from 40 to 40½ in.	10 segments

In order to provide the lap joints of the different segments after the completed inside and outside rings have been machined, a section of the outside or plain (rectangular) ring 1-7/8 in. in length is cut off and riveted to a segment of the inside or L-ring so that when finally assembled this spacer makes it impossible to assemble the rings in such a manner that the joints in the inside and outside rings coincide.

Facilities for Producing Rings

Both the plain rings and the L-rings are produced from cast iron tubs on two vertical turret lathes. After the machining is completed the rings are sawed into segments by means of a power saw on a saw table equipped with a spacing device which enables the operator to saw the solid rings into the desired number of segments. From this location the segments pass on to an electric drill which is used to drill and countersink the holes for the rivets in the spacer section of the rings. Next a pneumatic squeezer is used to set the rivets, then a pneumatic hammer to drive the rivet heads home. A bench grinder is used to grind off the rivet heads

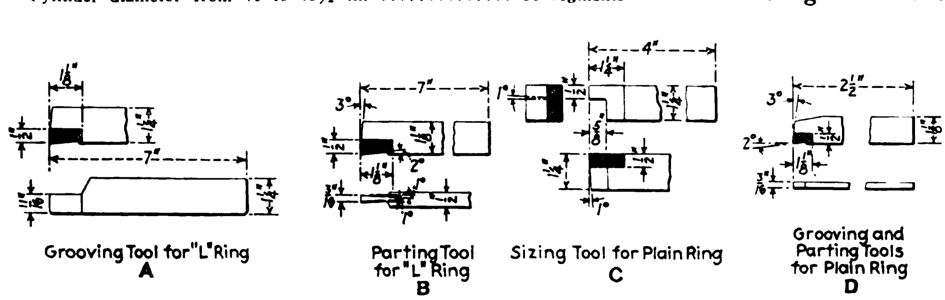
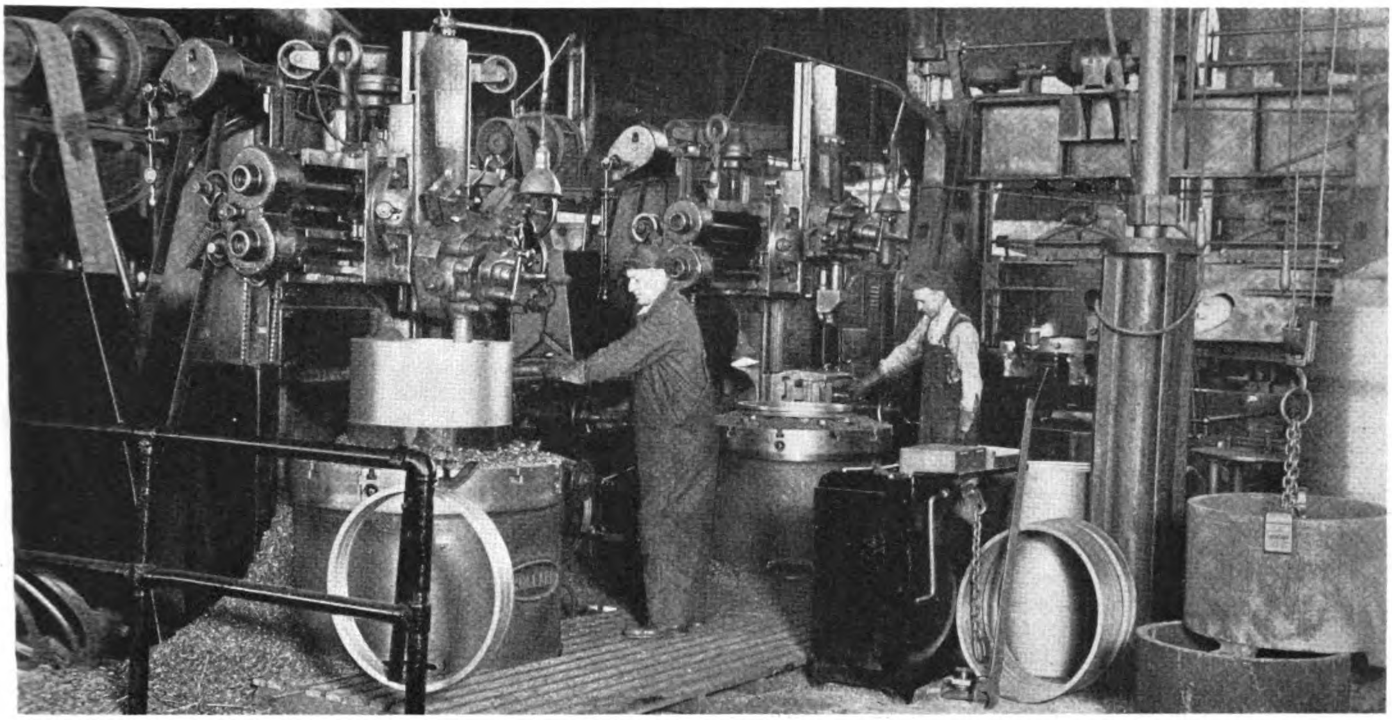


Fig. 2—Tool details



General view of the cylinder packing-ring production department at West Albany

flush with the surface of the ring. Next, the segments of a complete ring set are wired together, after which they are given an oil bath. They are then dried, wrapped in burlap, and tagged with the cylinder size, ready for shipment.

Production Methods

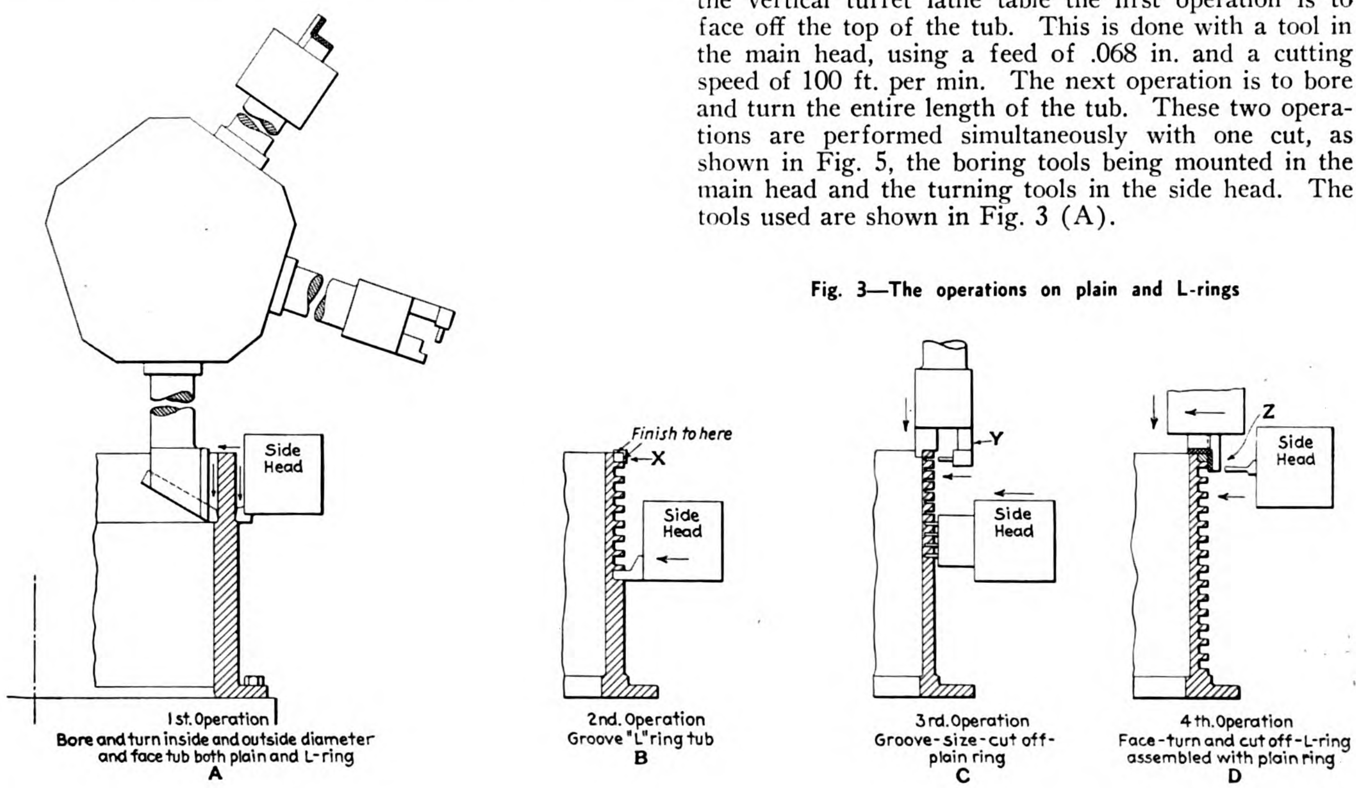
With the exception of the fact that different sizes of rings are cut up into varying numbers of segments, the production method is the same for all sizes of rings. In order to follow the operation through from start to finish, this article will deal with a ring set for a cylinder diameter of 28 in. Reference to Fig. 1 will indicate that the finished assembled ring is $^{13}/_{16}$ in. by 1-$^{1}/_{16}$ in. in cross-section and that the inside and outside diameters of the plain and L-rings are as follows:

	L-rings	Plain rings
Finished outside diameter, in.	28	28
Finished inside diameter, in.	25⅞	26½
Rough packing tub outside diameter, in.	28½	28½
Rough packing tub inside diameter, in.	25⅜	26
Length of rough packing tub, in.	16¾	17
Number of segments in ring	8	8
Number of rings produced from one tub	15	22

Machining Operations on Plain Rings

After the rough tub for the plain rings is set up on the vertical turret lathe table the first operation is to face off the top of the tub. This is done with a tool in the main head, using a feed of .068 in. and a cutting speed of 100 ft. per min. The next operation is to bore and turn the entire length of the tub. These two operations are performed simultaneously with one cut, as shown in Fig. 5, the boring tools being mounted in the main head and the turning tools in the side head. The tools used are shown in Fig. 3 (A).

Fig. 3—The operations on plain and L-rings



The gages shown in Fig. 4 are used to obtain correct inside and outside diameter of the tubs without the use of pin or snap gages. These gages are placed in the positions shown, the boring and turning tools placed against the gages and bolted fast.

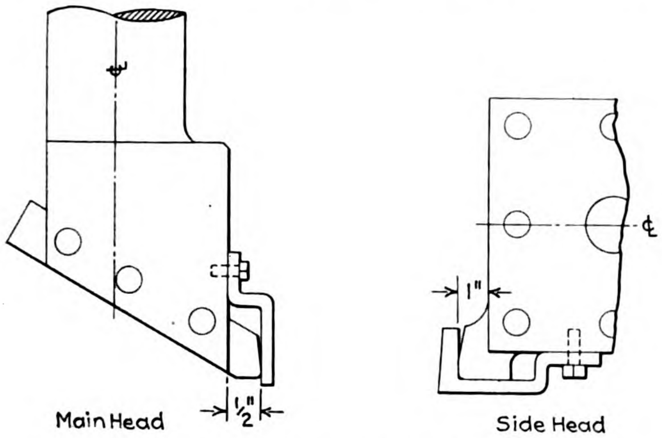


Fig. 4—Gages used for setting boring and turning tools

The first tub of each diameter is bolted to the table and the correct inside diameter is obtained by using a pin gage. The correct outside diameter is obtained by using a snap gage. The reading on the feed-screw dial is then taken on both main and side heads and a record made. On all subsequent tubs of this same size the correct inside and outside diameters are obtained by setting the heads to dial readings. Each time a tool is removed for grinding it is relocated in the holder by using the gage shown in Fig. 4.

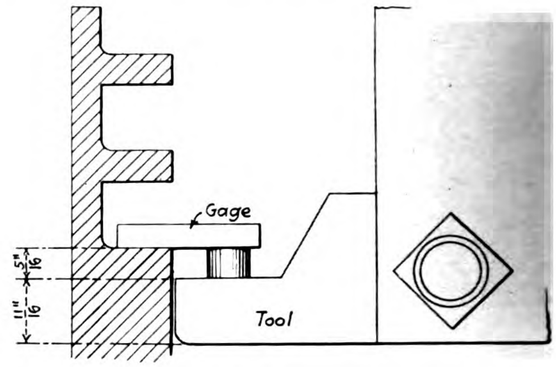


Fig. 6—Gage for setting the grooving tool for the L-rings

After the boring and turning operation is completed the next step is to cut the grooves in the tub for the 22 rings. This is done with a gang tool in the side head shown in Fig. 3 (C). The grooves are cut 3/16 in. wide and to a depth of approximately 5/8 in. In starting the cut for the first three rings the gang tool is set vertically

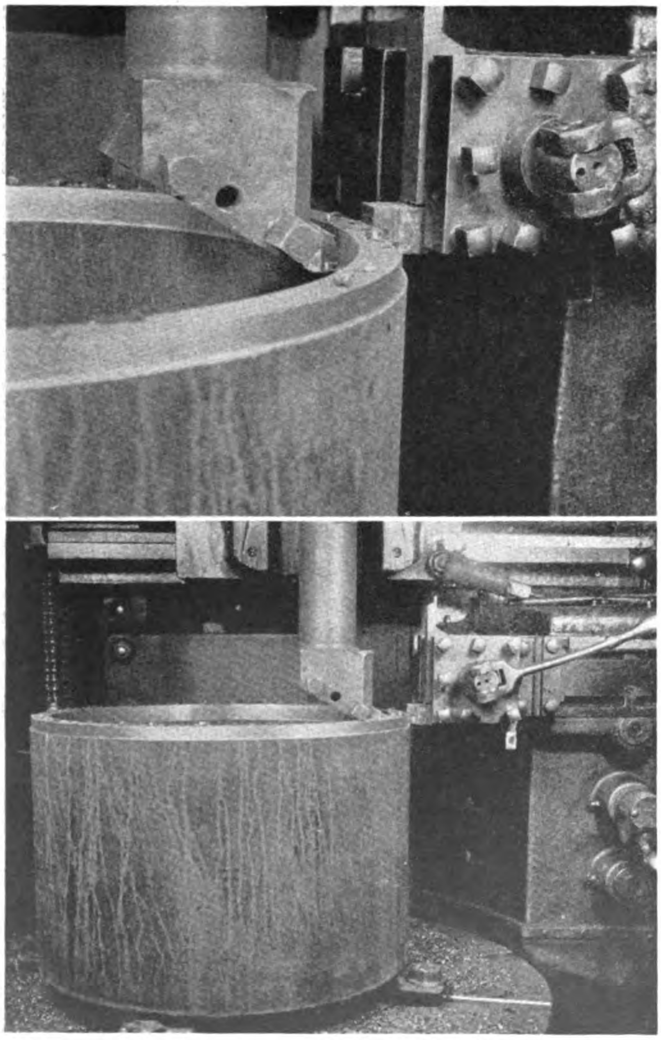


Fig. 5—Two views of the turning and boring tools starting the two-cut operation on a rough tub

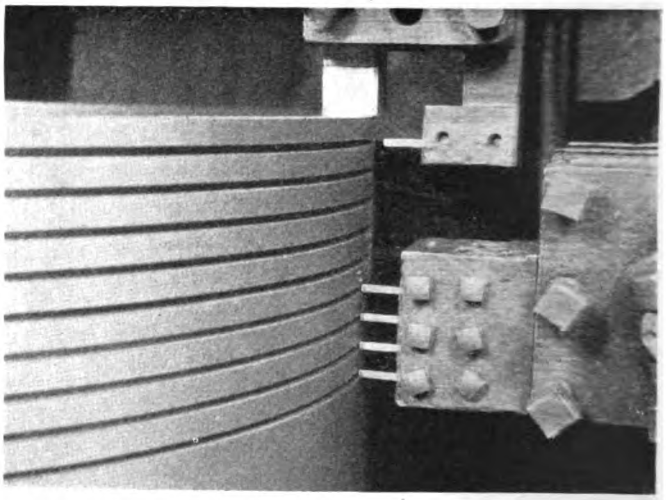


Fig. 7—The gang tool cutting grooves in the tub—The parting tool is shown at the top ready to be used, while the facing tool is seen in action

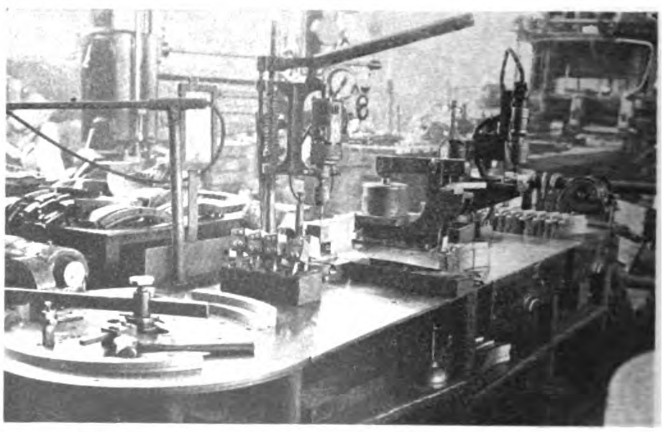


Fig. 8—A general view of the bench where the rings are prepared for assembly—From left to right: The segment saw, sensitive drill, riveting press, riveting hammer and grinder

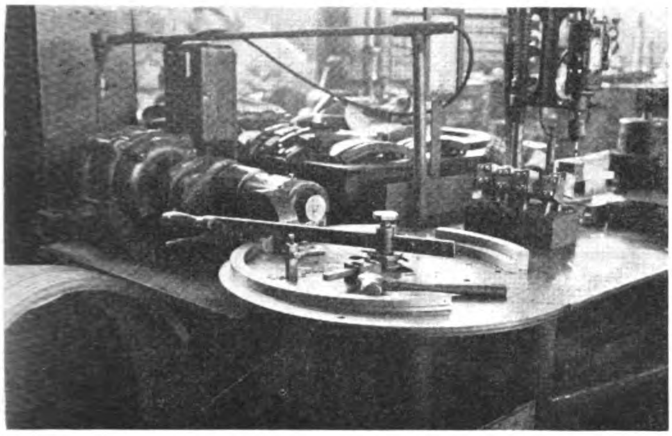


Fig. 9—A close-up of the power saw showing the arrangement of the selector bar and stop pins for sawing rings accurately into varying numbers of segments, as desired

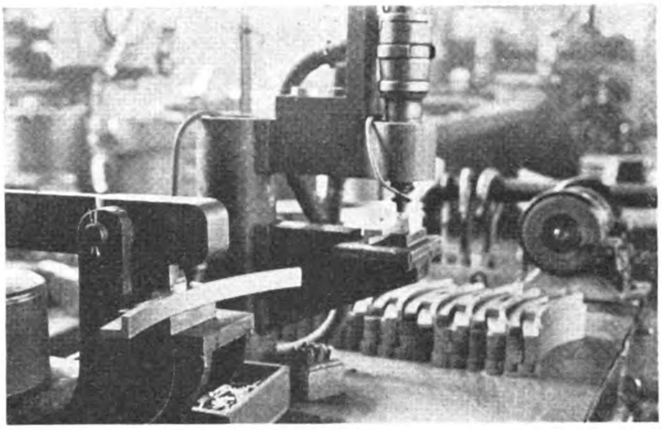


Fig. 11—The rivets are pressed in with the pneumatic press in the foreground and riveted over with the hammer in the background—After riveting the heads are ground flush

by lining up the bottom of the upper one of the four tools in the holder with the finished top surface of the tub. The remaining three tools are then fed into the work to cut three grooves. For the next four grooves the gang tool is set by the use of a gage similar to that shown in Fig. 6 by means of which the location of the top one of the four tools is established. This procedure is followed after each set of grooves is completed until all of the grooves for the 22 rings have been cut. After the first seven grooves have been cut and while the remainder of the grooves are being cut, the combination tool in the main head in Fig 7 and at *Y* in Fig. 3 (C) is brought into use. This tool faces the top and inner face of the ring and also cuts a fillet on the inner edge of the ring. The parting tool of the combination is then fed into the groove and cuts off one ring.

With this combination by the time 22 grooves are cut 11 of the rings have been parted from the tub.

Machining Operations on L-Rings

After the rough tub for the L-rings is set up on the table of the vertical turret lathe, the first operation is to face off the top of the tub. The tools used for this operation are set up in the main head. A feed of .068 in. and a cutting speed of 100 ft. per min. are used for this operation. The next operation is to bore and turn the full length of the tub. These two operations are performed simultaneously with a boring tool in the main head and a turning tool in the side head, as shown in Fig. 3 (A). The gages for setting the tools are shown in Fig. 4. The feed on the boring and turning operation is .068 in. and the cutting speed 100 ft. per min. After the tub has been bored and turned the next operation is to cut the grooves for all of the 15 rings. The groove for the first ring is cut, with the tool shown in Fig. 2 (A), ½ in. wide and ¾ in. deep, and the 14 successive grooves are cut in the tub 1$\frac{1}{16}$ in. wide and ¾ in. deep. After the first groove has been cut at the top of the tub the gage shown in Fig. 6 is used to establish the position of the grooving tool for the next cut. This gage consists of a short bar with a button exactly $\frac{5}{16}$ in. (.3125) in height on the bar. The bar is laid on the bottom surface of the last groove cut and the tool in the side head tool post is run up until it touches the button on the gage.

After all the grooves for the 15 rings in the tub have been completed the operator working on the L-rings takes a plain ring and fits it to the top of the machined tub, as shown at *X* in Fig. 3 (B). This is a light driving fit.

The $\frac{3}{16}$-in. parting tool shown at *Z* in Fig. 3 (D) in the side head and in Fig. 2 (B) is now run up to the under side of the top ring and pressure applied so that a light finishing cut is taken, then the cross-feed is engaged and the parting cut started.

The combination tool shown in the main head is now brought down to take a light finishing cut on top of the assembled ring, then fed in to take a light finishing cut on the outer diameter. (Note that the combination tool is turned to the left in the head so that, looking at the

(Continued on page 552)

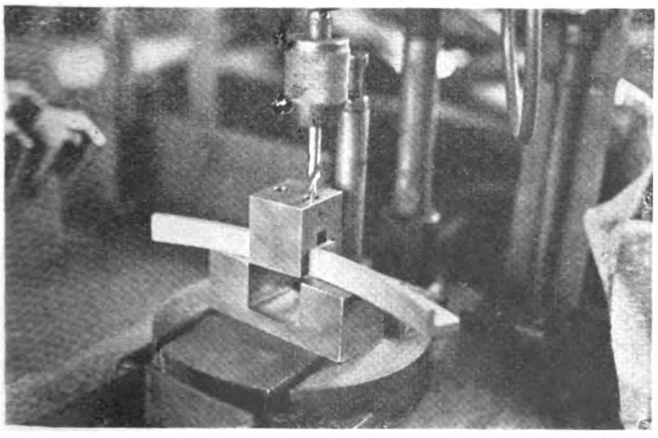


Fig. 10—In order to provide the lap joints a short section of the plain ring is cut off and riveted to the L-ring—Here is the drill jig that locates the rivet holes

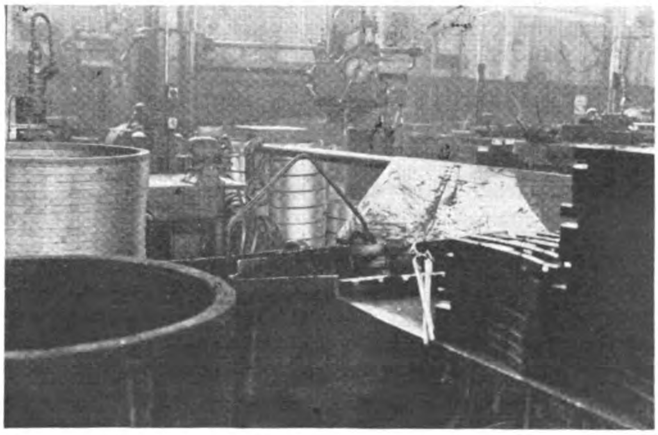


Fig. 12—After assembly the rings are dipped in a bath of lubricant, made up in sets and wrapped in burlap for shipment to the outlying points on the system

All Out of Step

ENGINE failure! The most generally despised words in railroad language. Every one connected with a railroad from call boy to the president hates engine failures and well they might. Engine failures can cause more trouble on a railroad than squeaky shoes on a sound movie set. Passenger trains late, delayed freights, schedules disrupted—the whole carefully planned routine of railroading is disrupted when a locomotive suddenly and unexpectedly throws up its tail and quits.

Division superintendents are not baldheaded from thinking—they have chief clerks to do their thinking for them. They get that way as a result of engine failures. They pull their hair out; some of it comes roots and all until eventually there's none left to pull. After the hair is gone they rub the bald spot. After a sustained epidemic of engine failures, a superintendent's head becomes as shiny as the turret top of a new automobile.

Dispatchers that beat their wives only do so when carefully arranged schedules are shot to pieces by an engine failure on the Limited. Master mechanics having most tractable dispositions have been known to show symptoms of maniacal tendencies such as breaking up the furniture and kicking harmless dogs during an epidemic of engine failures.

Fortunately, engine failures are the exception rather than the rule. If that were not true, there would be a lot of PWA projects building insane asylums for demented ex-railroad officials. Better power, better equipment, better methods, and last, but not least, better men on the railroads are some of the reasons why, in spite of faster schedules and heavier trains, engine failures are not as numerous as might be expected.

If it ever becomes necessary to build asylums for railroad officials afflicted with dementia praecox, as alienists in court call plain crazy, special padded apartments should be provided for roundhouse foremen.

Superintendents may pull their hair, dispatchers beat their wives, and master mechanics have violent outbursts of the wimwams over engine failures, but roundhouse foremen can indulge in no such luxuries. It's their job to see that locomotives are in condition to make trips and keep on making them without delays. The late chain letter fad—peace to its ashes—didn't originate in Denver, Colorado, as is credited. It started many moons ago by railroad officials wanting to know the why of engine failures. The roundhouse foreman is the last link in the chain. Like the caboose on the end of a freight train, he gets the hardest jolt.

The Plains Division of the S. P. & W. has a pretty good engine performance record now, but there was a time not long ago when it stood out like a sore thumb of a hitch hiker. H. H. Carter had been master mechanic on the division about a year then. Jim Evans, the roundhouse foreman, was already considered an old timer at Plainville, having been on the job four or five years. Hard luck and Bill Walker hit Plainville at about the same time. It was Walker's first job as a general fore-

"What you got on your mind?" Evans finally asked

3ut Bill

by
Walt Wyre

'I've got plenty. Sit down; I want to talk to you"

man. It came very near to being the last job he held.

Walker had put in most of his time in a supervisory capacity as a working foreman at an intermediate division point before coming to Plainville and it took some time to get the hurry-up idea out of his head.

WALKER put on his rush act at the drop-pit first. Morgan and Jenkins with their helpers were getting ready to put up the drivers on the 5091. Morgan was checking the fit of the newly bored right main driving-box brass.

The general foreman, watching the machinist, began to get fidgety. "Anything wrong with it?" Walker asked.

"Seems to fit a little too soon. Believe I'd better send it back to the machine shop and have a light cut taken out of it," the machinist said.

"Well, if you think it'll have to have it, go ahead, but we want to get the engine out." Walker's voice showed the impatience he felt.

The boring mill had another job in it and it would be an hour or more before the operator could get to the driving-box. Morgan decided to take a chance.

"When you figuring on getting the engine out?" the foreman asked Jenkins.

"Oh, if we have good luck, we should get it out day after tomorrow."

"I noticed you didn't seem to be in much of a rush," Walker said somewhat irritably.

"Sometimes it doesn't pay to get in too big a hurry," the machinist said mildly.

"Well, things are going to have to speed up around here. I want this engine out tomorrow by five o'clock." The foreman turned and went to the office.

"The men here don't seem to be in much of a rush," Walker remarked to Evans.

Evans let his feet drop from the top of the desk. "Oh, they do pretty well. Pretty good bunch of men."

"Those two machinists at the drop-pit. What are their names? I've been watching them all morning. They are slower than relief workers.

"You mean Morgan and Jenkins? They're not so slow. If you check up on them day in and day out, you'll find that they turn out about as much work as any two machinists you'll find. Their work stands up, too." Evans reached for his plug of horseshoe and went to the roundhouse.

The 5091 was off the drop-pit next day and failed that night. They ran it east on a drag, twenty-eight miles east to be exact. The right main driving-box burnt up. Driving-box wedges being too tight contributed to the cause of the box running hot. The drag made a main line meet with the Limited. The passenger train lost an hour and fifty minutes. The superintendent of motive power being on the Limited didn't help matters any.

Walker pulled the two machinists out of service,

claiming that the nut splitters had deliberately laid down on the job because of his urging them to hurry the job up.

Evans swore fluently and fervently at losing his two best drop-pit machinists for ten days. Every man in the roundhouse knew the circumstances in the case. Somebody nicknamed the new general foreman "Wild-eyed" Walker.

Echoes from the howl over the failure of the 5091 hadn't died away when the failure of the 5084 started it all over again.

Hines, a pipe fitter, was putting up an air pipe on the engine. The pipe didn't fit and Hines started to take it back to the shop to heat the pipe and change one of the bends.

"What you going to do with that pipe?" the general foreman asked.

"Shorten the bend so it'll fit," Hines replied.

"Jumping Jupiter!" the foreman ejaculated, "and you call yourself a pipe fitter! Get a long bar; I'll show you how to make it fit."

After much heaving and prying the pipe was lined so the union could be screwed up. "No wonder you fellows have a hatful of slips left not worked every evening," Walker said as he walked away brushing his hands.

"I guess old Wild-eyed got you told," the pipe fitter helper jibed.

"Yeah, and if he says much when that pipe breaks, I'll get him told!" the pipe fitter replied.

His guess was correct. The pipe did break. It withstood the strain and vibration two trips before snapping off at the union. The Limited lost an hour and fifteen minutes while temporary repairs were made by a garage mechanic.

The next failure couldn't really be charged to any one. It was one of those more or less unpreventable failures that will happen occasionally as long as man made machines operate. The whistle valve stuck open on the 2872.

Careful examination of the whistle valve failed to reveal the cause. No one was blamed directly for the failure but that didn't keep it from adding one more to a mounting list of engine failures. It didn't keep half the people of Middleton from writing to officials of the road complaining of the whistle blowing thirty minutes on Sunday morning when they were trying to sleep.

In the meantime, Jim Evans was having troubles of his own. The power was in bad shape and rapidly getting worse. Every day when five o'clock came there were piles of work slips, each slip representing jobs not done. Apparently the men were working harder than before, but results didn't show it. Engines were seldom finished when expected. Terminal delays became more frequent.

The atmosphere of the shop had changed, too. The men no longer joked and kidded during noon hour and in the washroom after quitting time. From eight to twelve and one to five they worked.

Seldom was a man seen loafing by a foreman, especially the general foreman. When he was around, the men worked with the nervous haste that spells havoc with good workmanship and efficiency. Walker was the most nervous of any. He jumped from one place to another like a hen on a hot griddle constantly urging mechanics to hurry up. One thing he hadn't learned was that the grapevine telegraph in a roundhouse is faster than any man can walk. As he went through the house, the signal that meant "Old Wild-Eye is coming" was always ahead of him. Clock watchers and boss watchers accomplish little else and the day force at Plainville had developed into both. Even Evans was beginning to acquire a nervous and irritable disposition.

In the meantime, engine failures steadily increased. Fourteen in thirty days was the score the first month. On top of that they ran over their allowance, mostly because of an extra amount of overtime. Jim Evans chewed up a dozen pencils and as many plugs of horseshoe trying to explain satisfactorily why the overtime had increased. He was frowning over another effort to answer a letter when the first-trick engine inspector entered.

"How is the 5062?" Evans asked.

"Pounding like a bunch of boilermakers on piece work," the inspector replied. "Rod bushings are worn over the limit. The rear tank wheels came in with keelys on both boxes and the engineer reported piston packing down and the left injector not working."

"Hope the bell ringer works," Evans remarked.

"No, it needs adjusting. The bell goes round and round. I've got it reported."

The office phone interrupted the conversation. John Harris, the clerk, answered it. "Hello . . . Yes, he's right here. . . . Train delayer wants to talk to you. Sounds like he's got a cockle burr under his tail," Harris said.

Evans grunted and expectorated about a pint of tobacco juice. "Hello . . . Yes . . . What!"—Evans swallowed hard—"O.K., I'll send an engine out right away."

"What is it now?" Walker had come in the office while Evans was talking to the dispatcher.

"Engine failure. The 5074 broke a main axle between Middleton and Huntsville."

"Do much damage?" he asked weakly.

"Wouldn't be surprised. She was doing sixty-five at least when the axle broke. It's a wonder she didn't mess up the right of way for a couple of miles," Evans added as he went in search of the hostler.

The general foreman followed him out of the office. "Guess we'll have to use the 5062," Walker stated rather than asked.

"Yeah—or the goat. They're the only two engines hot," Evans replied.

"You get a couple of machinists lined up to go. I'll help the hostler get the 5062 turned and ready."

The general foreman stood first on one foot then on the other while the engine was taking water and oil. He stood by the switch motioning the hostler to come ahead while the helper looked to see if there was sufficient sand in the dome. He walked two miles in a circle around the locomotive while the engineer was oiling round getting ready to go.

Next morning there was a message lying on top of the morning mail on the desk. "More bad news, I guess," Walker said as he picked up the pink slip of paper.

Evans noticed that Walker's hand trembled when he picked up the message. As the general foreman read the typewritten message, his face flushed. A line of white edged the wrinkles on each side of his mouth. He swallowed as though he was trying to down a large, hard lump of something too dry to swallow.

"What is it?—another engine failure?" Evans asked.

Walker silently handed Evans the message: "Engine

5062 tied up by government inspector account of Federal defects at Sanford date. Will advise later." The message was signed H. H. C., the initials of the master mechanic."

"Well, I guess that'll just about be the last blow," Walker said. "On top of all the engine failures and delays we've had since I've been here, I can't expect anything else."

Evans opened his mouth to say something. Instead he shoved a hunk of horseshoe in his mouth and went to the roundhouse.

The general foreman slumped down at his desk looking as dejected as a ten-year-old boy that had lost his dog. All morning he stayed in the office nursing his grief and pitying himself. He had done his best, Walker told himself. The men were laying down on him. Evans wasn't cooperating. Every one was against him. No one could have done any better under the circumstances, he told himself bitterly. "And, by heaven, I'm going to tell them so!" Walker spoke the last half aloud.

"Did you say something, Mr. Walker?" the clerk asked.

"No,—yes—I did. Make a bulletin to all shop employees saying that there'll be a meeting in the machine shop at one o'clock and every employee must be present. Make enough copies and post them all over the place so that no one will miss seeing them. And tell Evans I want to see him in the office," he added.

Harris obeyed the last request first and went in search of the roundhouse foreman.

TENSE silence filled the little room as the two foremen faced each other, each waiting for the other to speak. Evans wondered just what it was all about; why he had been called back in the office and the door closed. Walker couldn't figure out just how to begin.

"What you got on your mind?" Evans finally asked.

"I've got plenty. Sit down; I want to talk to you."

"O. K., go ahead; it might do us both good."

Walker was nonplussed for the moment by Evans' reply. He nervously arranged and rearranged the papers on his desk. He cleared his throat two or three times. "Well, I guess you'll be glad that I'm leaving."

"Hope you take this run of hard luck with you," Evans replied evenly. "Where you going?"

"I don't know and don't much give a damn, but I hope it'll be some place where the men I'm working with will cooperate."

"Everybody out of step but Bill," Evans murmured.

"What?"

"Nothing; just happened to think of an old song."

"Well, I'm in no humor for songs. I just wanted to tell you that I'm leaving—by my own request. It's plain to see you've worked against me ever since I've been here. The men have been laying down on me, too, and I'm going to tell them so! I've called a meeting for one o'clock. I want you to be there. I came here hoping to make good, and I could have if you had worked with me," Walker said bitterly.

"Is that all?" Evans asked without raising his voice.

"Yes."

"The song I mentioned was something about everybody being out of step but one," Evans said as he left the office.

"It's so near noon, don't you think I'd better put one of these bulletins on the clock so the men will see it when they stamp out?" the clerk asked.

"Maybe it's too late anyway. Tear them up. Did Evans bid on the general foreman's job when it was vacant?" Walker asked.

"I don't think so. He owns his home here and is pretty well satisfied where he is. He has had chances to go to better jobs but didn't like the idea of moving around. Everybody likes Evans," Harris added.

"Guess he wasn't trying to get my job after all. I thought maybe he was," Walker said, half to himself.

THE twelve o'clock whistle interrupted the conversation. The general foreman didn't go home to lunch. He was in the office when Evans returned at twelve-forty.

"Call the meeting off?" Evans asked.

"Too late to get the bulletins up. I may not have any meeting—just ease out and leave it with them."

"Good idea," Jim said.

"My leaving?"

"No, not having the meeting. Wouldn't do any good and might leave some sore spots."

"Why have I had so much trouble here? Goodness knows, I've tried hard enough."

"Maybe you've tried too hard."

"What do you mean?" the general foreman asked almost pleadingly.

"Well, you asked me; I'm going to tell you. Giving advice is about the most profitless thing a fellow ever did, but here goes.

"You have been so anxious to make good you've let your anxiety overcome your judgment. Nobody could keep pace with your ideas and you thought the men weren't doing anything. Men hate to be driven. When you took Jenkins and Morgan out of service, everybody knew it wasn't their fault the engine failed. That gave you the reputation of being unfair. Then constantly rushing the men, even when they were working at a fair rate. They decided that if they had to work like killing snakes to satisfy you they'd just make up for it when you weren't around." Evans reached for his plug of horseshoe.

"Maybe you're right, but it's too late to change it now. I'm sorry for what I said before noon. I'll just call that meeting this afternoon and tell the men, too."

"I wouldn't do that," Evans advised.

"What would you do?"

"Oh, if I felt like I had mistreated any one, like Jenkins and Morgan, for example, I'd tell them so. Then I'd take a few days off and start over. Talk to the master mechanic about it. Carter is nobody's fool."

FAILURES did not stop immediately, but conditions improved. In less than a year the dispatcher and his wife took a second honeymoon. A patch of fuzz was beginning to show on the superintendent's bald spot, and the master mechanic hadn't had a fit in months.

Walker did finally call a meeting of all the men. Their was deep feeling in his voice when he told them he hated to leave Plainville. There must have been an epidemic of colds; at any rate, most of the men found it necessary to blow their noses.

When Jim Evans, acting as spokesman for the men, presented Walker with a traveling bag, Evans stammered and stuttered like a bashful boy speaking a piece. He did manage to say that while every one hated to see Walker leave, they were glad he was getting a better job.

Walker must have had a cold, too, the way he blew his nose.

Quantity Production of Piston Packing Rings

(*Continued from page 547*)

machine from the front, the tool works behind the parting tool. The parting and facing are done simultaneously). The parting tool serves the dual purpose of finishing the bottom of the assembled rings with one cutting edge at the same time that it is parting them from the tub. The same procedure is followed in assembling, facing, turning and parting the remaining 14 rings. On the facing and turning operation a feed of .010 and a cutting speed of 100 ft. per. min. are used. On the parting operation a feed of .011 and a table speed of 48 ft. per min. are used.

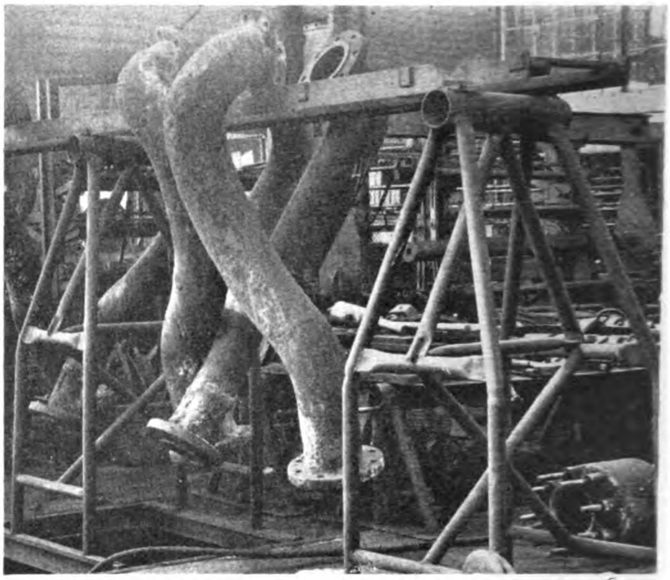
Production is at the average rate of 90 plain rings and 45 L-rings each eight hours.

Keeping a Locomotive Shop Clean

"Cleanliness is next to Godliness" and both cleanliness and good order are highly stressed at the Denver, Colo., shops of the Chicago, Burlington & Quincy. Special racks used in keeping cylinder heads, binders, steam pipes, etc., off the floor are shown in the illustrations. One of these, which gives a general erecting shop view, shows in the foreground a special cylinder head rack made of two steel rails spaced 24 in. apart and having 27-in. vertical flue sections, spaced 10 in. on centers and welded to the bottom rails. All cylinder heads are kept in this rack where they occupy a minimum of floor space, present a neat appearance, and where the steam joint surfaces are protected from damage. Valve chamber heads are kept in the forward part of this rack.

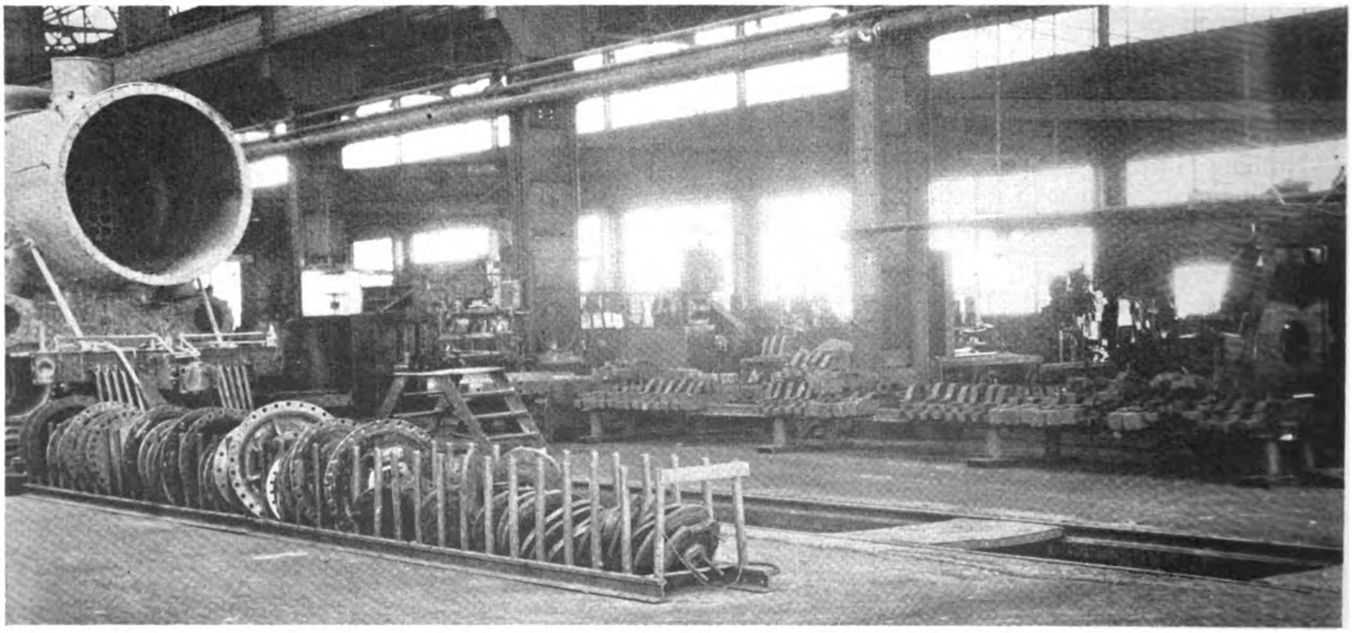
In the background of the picture is shown a similar rack for locomotive binders in which the two steel rails, 30 ft. long, are spaced 22 in. on centers and supported 2 ft. above the floor level by means of short lengths of superheater pipes welded to cross sections resting on the floor and made of 10-in. steel channels. As in the case of the cylinder head rack, this rack provides a convenient place where drawbars may be kept off the floor in the interests of safety and where they can be readily located by shop men for purposes of inspection, measurement, repair, etc.

Possibly the most awkward parts handled in railroad shops are locomotive steam pipes which are used in widely varying sizes and shapes. The special rack used at Denver shops for keeping these steam pipes in some kind of order and off the floor where they present a



Special cylinder head and binder racks used at the Denver, Colo., shops of the C. B. & Q.

constant hazard to passing shop men is shown in the illustration. It consists essentially of frame work 24 ft. long by 6 ft. high with the supporting tubular steel frame and legs 35 in. wide at the bottom. This frame work is made of boiler tubes and tubes jointed by welding, as shown in the illustration. The short sections of superheater flue at the top support two steel rails which are spaced 18 in. apart and tipped on their sides so that the rail flanges will extend under the steam pipe flanges and hold the steam pipes safely in a vertical position.



Welded tubular steel rack where steam pipes may be kept safely off the floor

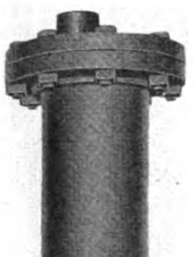
The top rails are held a fixed distance apart and with their bases vertical by means of several short spacer bars welded in place. Another advantage of this rack is that it prevents possible damage by the breaking of flanges which sometimes happens when steam pipes are left more or less carelessly lying around on the shop floor.

Oil and Water Condenser For Air Lines

A condenser designed for extra-heavy duty in removing oil and water from air lines has recently been placed on the market by the DeVilbiss Company, Toledo, Ohio. This condenser, designated as type HP-504-2, is designed with a baffle arrangement within the condenser and a pair of filter pads located in such a way that they can be removed and replaced without disconnecting the condenser from the air line.

Air inlet and outlet are both in the top cap which is fastened to the body of the condenser by means of a companion flange. This permits removal of the body of the condenser without disturbing the air line. The filter pads, which fit around the inlet tube and interior wall of the condenser tube, stop passage of any oil, water or dirt. The average life of these pads is said to be approximately three months. A drain valve on the bottom of the condenser permits drainage of accumulated condensation.

The Condenser is 4 ft. 8 in. long, has a tube diameter of 6 in., takes a 2-in. pipe thread on inlet and outlet tubes, and has a net weight of 140 lb.

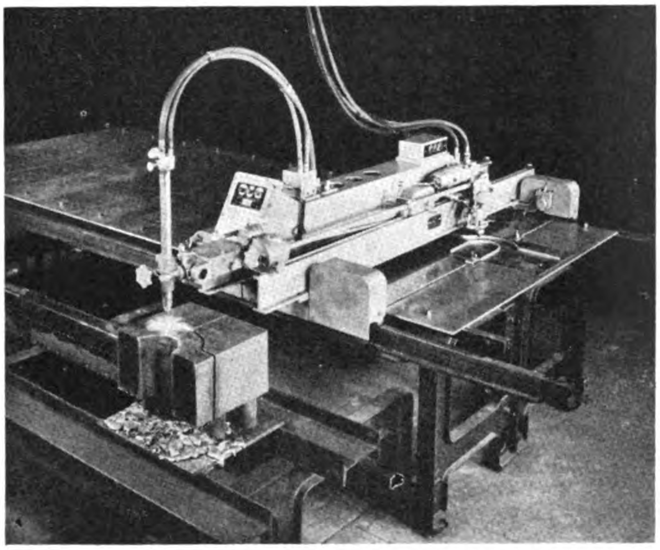


DeVilbiss condenser for removing oil and water from air lines

Oxweld Shape-Cutting Machine

The Linde Air Products Company, New York, recently introduced the Oxweld type CM-12 shape-cutting machine which is designed to increase the accuracy and range of flame-cutting. The flexibility of this machine is such that any shape, from the simplest to the most complicated, can be flame cut either automatically with templets or guided by hand. The immediate transfer of motion from one end of the machine to the other is an important factor in assuring precision in all cutting operations.

In addition to cutting shapes of all description, the machine will cut straight lines automatically in any direction and at any bevel. Cuts as long as 144 in. are possible and an important feature lies in the fact that straight-line cuts can be made at any desired angle in the horizontal plane. A special circle-cutting attachment is also provided, thus enabling the automatic production of circles from 2 in to 24 in. in radius. Still another feature is that of multiple cutting. The apparatus is designed to carry from two to five blowpipes which can perform multiple cutting operations under all the conditions possible with a single blowpipe.

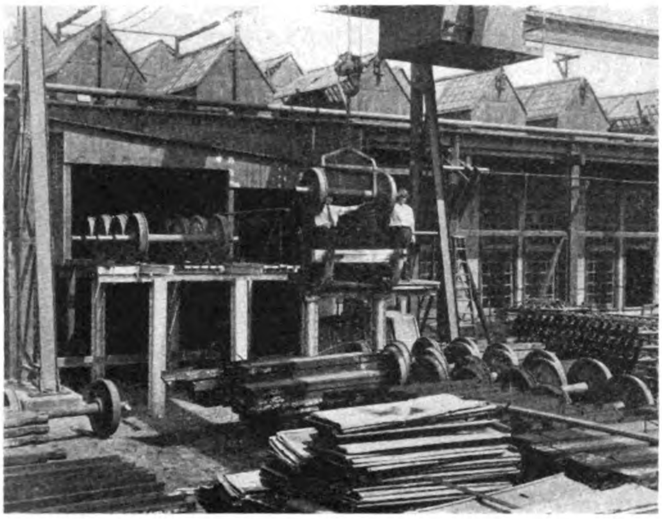


Oxweld CM-12 shape-cutting machine

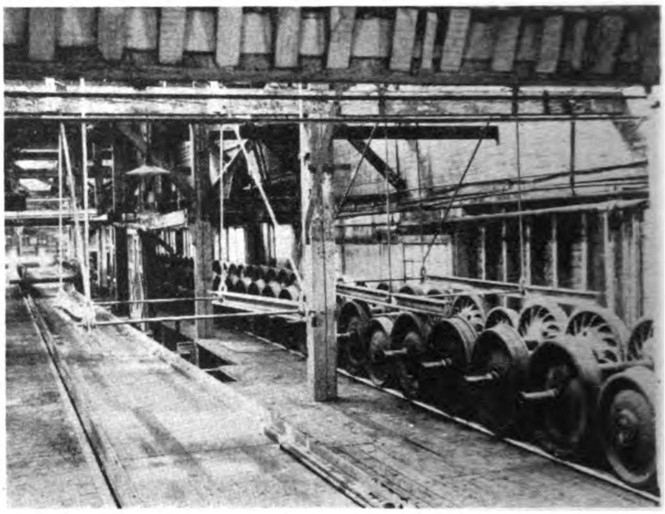
The features of design and construction which make possible the accomplishments of this shape-cutting machine typify the trend in modern machine development. Alloys have been utilized to establish an ideal strength-weight ratio combined with the necessary stability and rigidity of construction. The vital working parts are completely inclosed to insure correct lubrication and freedom from maintenance. The motor is rated at $\frac{1}{3}$ hp. and is more powerful than on any other shape-cutting machine in this class. The speed range of the unit is from $1\frac{1}{2}$ to 75 in. per min. All important controls have been duplicated so that operation is possible from either blowpipe or tracing position.

The blowpipes used have been constructed to give greater flame stability and increased economies in cutting. Material up to 12 in. in thickness can be handled; for heavier cuts a special blowpipe is available. The sensitive tracing mechanism, accurate scale calibrations and freedom from friction and vibration make precision cuts a routine accomplishment.

With the Car Foremen and Inspectors



Yard crane removing wheels from the elevated track



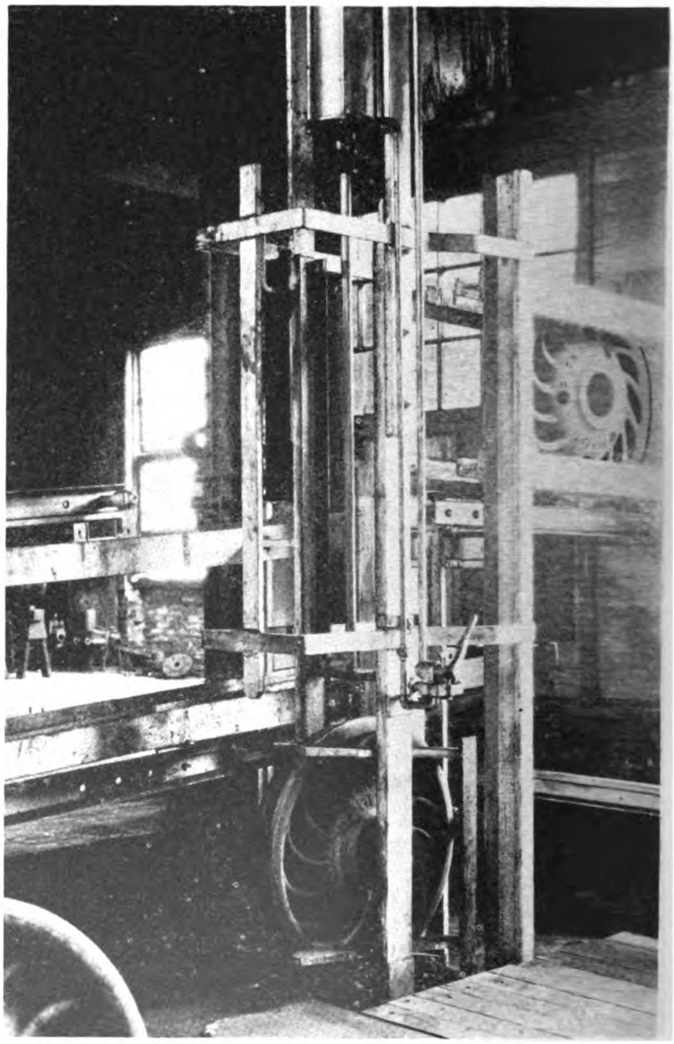
Incoming and outgoing tracks with retarders in place

Wheel Repairs on the Canadian National*

Wheel repairs at the Point St. Charles shops of the Canadian National are now being made in a renovated shop equipped with facilities which permit the continuous movement of wheels during repair operations and which eliminates unnecessary handling and rerouting of wheels and axles. The incoming and outgoing tracks to and from the wheel shop parallel each other on an elevated structure supported 9 ft. above the wheel shop proper. This structure extends into the wheel yard a sufficient distance to enable the yard crane to place wheels on the incoming track and to remove repaired wheels from the outgoing track.

The incoming track is 350 ft. long, is inclined 6 in. in its entire length, and holds 130 pairs of wheels. Retarders are hung at convenient points along the track to control the speed of the wheels as they move to the end of the track which extends to a point over and just in front of the pressoff machine. The wheels are lowered into the press by an electric hoist. The outgoing track, to which wheels are elevated by means of an escalator, is 220 ft. long and holds 80 pairs of wheels. It is also equipped with retarders to control the speed of the wheels as they roll toward the storage yard.

Other handling equipment in the shop includes chutes for handling new and scrap wheels, and an inclined track for loading scrap axles. New wheels delivered to the shop are rolled down a chute made of used rails. This chute is 50 ft. long, has an adjustable exit, and terminates near the wheel storage and boring mills. The speed of the wheels rolling down the chute is controlled by a retarder. The handling of scrap wheels is accomplished by a similar chute, but the wheels must be elevated from the shop floor to the chute so that they can roll down an incline to a loading car. The wheels are raised from the shop floor to the chute by an air-oper-



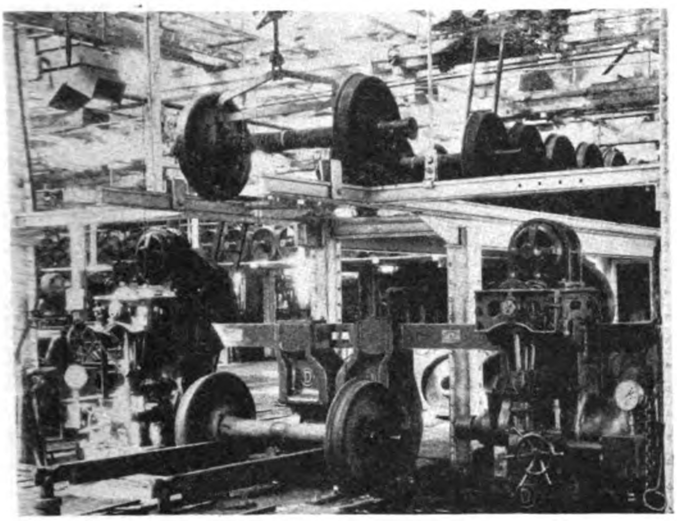
Elevator for raising scrap wheels from floor to discharge chute

* Based on an article which appeared in the October issue of the Canadian National Railways Magazine.

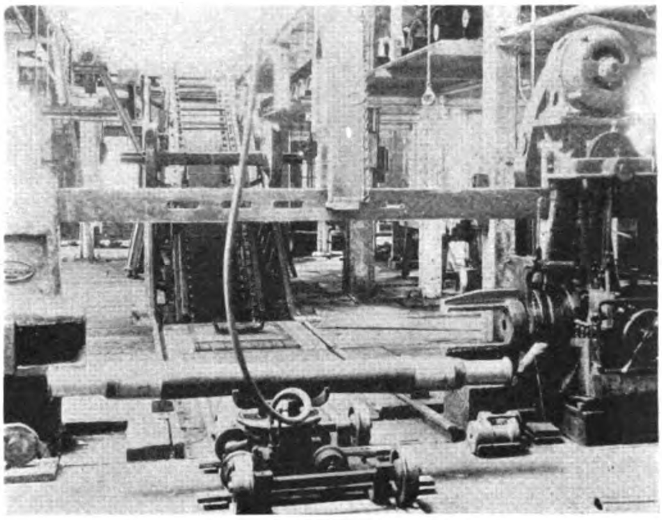
ated cage fitted with an unloading cam which pushes the wheel from the cage to the chute. Scrap axles are rolled from the shop to a loading car on an inclined track 2 ft. high.

If a pair of wheels enter the shop marked "scrap wheels and scrap axle," they are lowered into the press and the wheels are removed and raised to the scrap wheel chute to be rolled to the loading car. The scrap axle is rolled to the car siding on the inclined track.

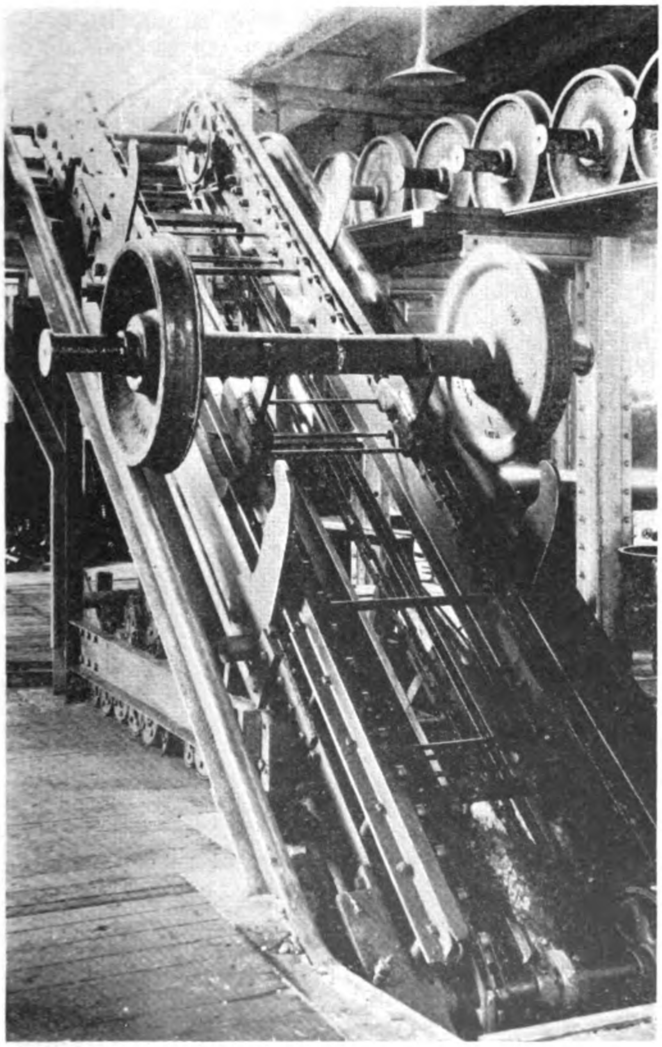
If a pair of wheels enter the shop with scrap wheels but with a good axle, they are lowered to the press, the wheels are removed and the axle is placed on a rack running between the axle lathes. The wheel seats and journals are turned and the axle is then placed on a rack down which it rolls to the mounting press machine and the boring mills. Wheel seat sizes are taken, wheels bored and applied, and the mounted wheels run through the press to the escalator and outgoing track.



Incoming wheels over the press rod for dismounting



Mounting press and yoke for removing misfit wheels



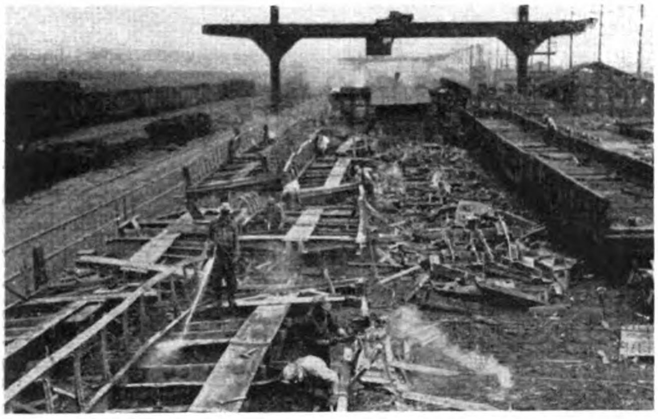
Escalator from shop floor to overhead outgoing track

If a third pair of wheels enter the shop with cut journals only, they are lowered from the incoming track, passed on to the journal lathes, and from there to the escalator to follow the preceding pair. At no point does one operation interfere with another, and since each operation follows in correct sequence there is no back-tracking.

The demounting press is of the double-end type and is used for stripping only. The wheels are lowered from the incoming track onto two rails 8 ft. long, fulcrumed at the end nearest the press, and operated at the other end by two air jacks. When the end of the rails are raised the wheels run into the press on their axles. In the case of wheels with cut journals, these rails are lowered to permit rolling the wheels to the journal lathes.

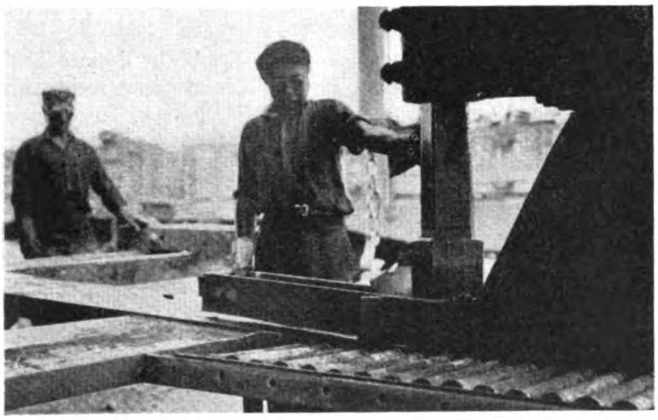
To keep operations in proper sequence it was necessary to fit the mounting press with a new yoke designed to permit journals to pass through the machine. A quick-acting assembly truck carries the assembled wheels through the machine and releases them for the short run to the escalator. To eliminate the necessity of taking misfit wheels back to the demounting press machine, a yoke was designed to hang above the mounting press. This yoke can be lowered and the wheel pressed off.

The escalator used for raising the wheels from the shop floor to the outgoing track is operated by two chains and standard sprockets at the top and bottom of the escalator. Two arms, designed as integral parts of the chains, engage the axle and pull the wheels to the top of the escalator. As the arms lower over the top sprocket and the wheels are released to roll down the outgoing track to the yard, another pair of arms are raised at the bottom of the escalator to engage the next pair of wheels. As the wheels roll up the escalator, counterbalanced arms are pressed down and when the wheels have passed they automatically raise to prevent wheels from coming back down the escalator in the event the chains break. The escalator, controlled by push buttons located near the press, is driven by a 7½-hp. motor.

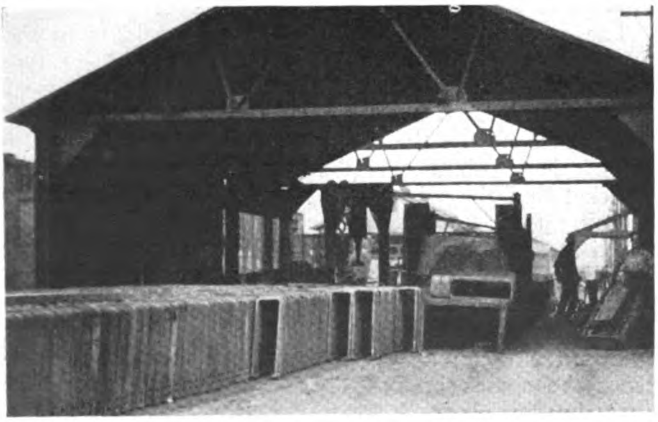


Pennsylvania car dismantling yard at Conway, Pa.

Separating yokes and couplers by a mechanical shear



Removing tail liners from coupler yokes



Reconditioning coupler yokes

Reclaiming Car Parts on the Pennsylvania

The Pennsylvania is now engaged in a freight car retirement program which is believed to be the largest project of its kind attempted at one time. The program includes about 32,000 box, hopper and gondola cars, equal to about 13 per cent of the freight-car equipment owned by the road, and, at its peak, was carried out at the rate of approximately 90 cars a day—22 at Terre Haute, Ind., 20 at Harrisburg, Pa., and 50 a day at the company's scrap and reclamation plant at Conway, Pa., near Pittsburgh.

Under the retirement plan, all cars subject to retirement are inspected when taken out of service for repairs, and if found unfit for repair are moved to the proper dismantling point where they are reduced to scrap by company forces working three shifts. About half the work is assigned to Conway because it is close to one of the largest freight classification yards of the railroad and has unusually extensive facilities for all stages of the work, including the reconditioning of materials suited for further use.

This plant is the largest railway scrap handling point in the country and employs about 450 men for all purposes. It occupies 90 acres of land, measures a half-mile in length from end to end of crane runway and has three gantry cranes as well as several locomotive cranes. The forward end of the truck yard, including about 1,000 ft. of land under the crane, is being used for all car dismantling, with the exception of the truck dismantling which is performed at the opposite end of the truck yard.

Condemned cars are brought to Conway in solid trains of 100 cars and are switched into the yard early each morning in 50-car lots, containing 20 box, 10 gondola and 20 all-steel hopper cars. The box cars and gondolas are placed on two parallel tracks within the craneway where the bodies can be removed by a gantry crane. One of these tracks is the outbound track for the scrap yard and the other is a stub-end track. The steel cars are placed partly on this stub-end track and partly on an adjacent spur where they are handled by locomotive crane.

During 1935, Pennsylvania forces repaired and otherwise reclaimed at Conway for further use 385,332 items of freight-car material, 6,744 tons of freight-car material being removed from scrap and shipped to the other points on the railroad for reclamation. The extent of

Ingenious fulcrum and air cylinder arrangement for closing coupler jaws

the repair work performed at this plant is shown in further detail in the table.

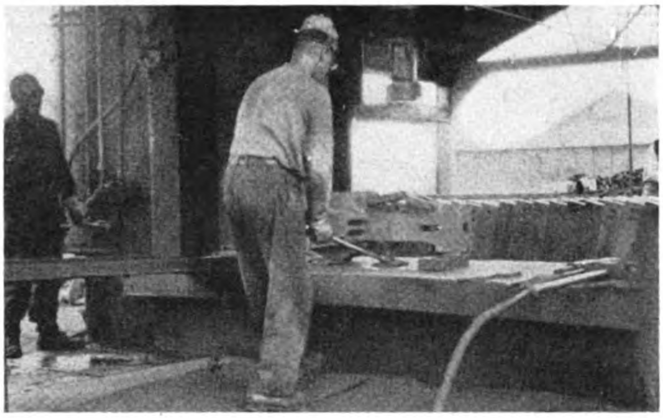
Items of Freight Car Material Repaired and Reclaimed at Conway, Year 1935

Coupler bodies	39,843
Coupler knuckles	40,948
Coupler knuckles and pins	38,245
Coupler knuckles, locks and lifts	32,464
Coupler yokes	29,620
Follower blocks	3,600
Striking plates	1,058
Carrier irons	2,501
Brake beams	48,692
Brake levers	3,784
Brake levers and spreaders	8,430
Brake hangers	18,386
Journal boxes	4,600
Journal bearings	22,800
Journal box lids	31,861
Journal box wedges	21,805
Hand brake wheels	2,117
Friction draft gears	807
Friction draft gear wedges	12,346
Truck center pins	12,475
Truck center plates	4,048
Truck bolsters pressed steel	863
Truck bolsters cast steel	2,299
Truck column castings	2,200
Bolts, square head cut off and rethreaded, tons	379
Nuts, all kinds, retapped, tons	82

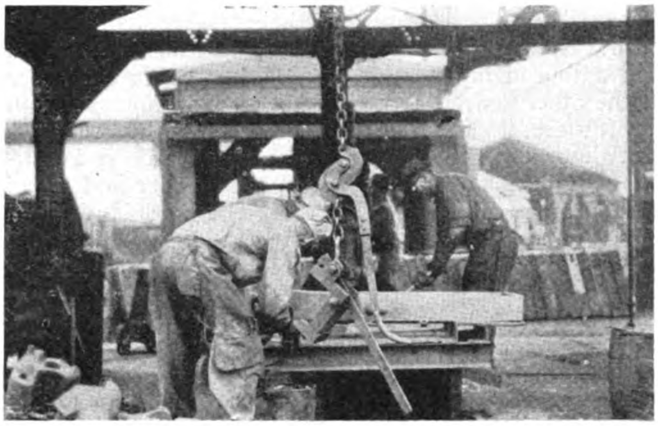
170 Couplers a Day

The plant is unusually well-equipped and organized to recondition couplers and brake beams. As the couplers with yokes are removed from condemned cars or separated from other materials in the scrap yard, they are brought to the reclamation yard by a gantry crane. The knuckles are detached and the couplers are then placed, four at one time, on a steel slide built about 3 ft. above the ground, where two men, one on each side, feed them under a press which separates the yoke from the coupler shank by a shearing action. This operation is performed at the rate of about 170 couplers a day. From this press the coupler slides down a chute to the ground on one side while the yoke is moved in the opposite direction to a second press where a third man shears off the tail liner. The yoke then moves on a gravity conveyor to the ground and the good yokes are passed through a furnace, then placed, while red hot, in a press which reshapes the yoke, shortens the lugs and automatically discharges finished yokes at the rate of about 25 an hour.

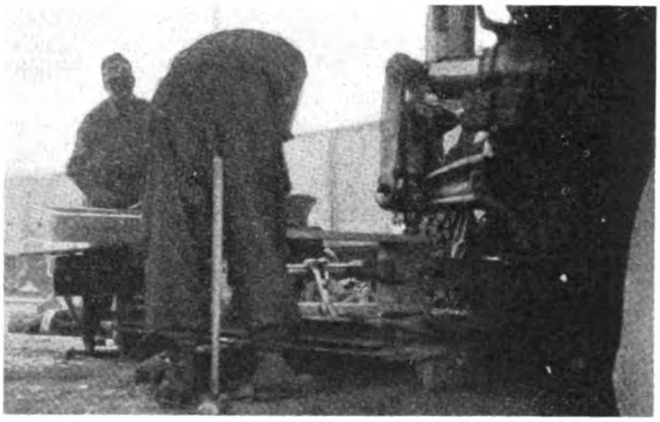
Meanwhile, the couplers are placed on an oil fire which holds four couplers and the heads brought to a red heat. They are then brought to their original contour by attaching the couplers, one at a time, to a fulcrum with a knuckle pin so that the shank is tilted upward. An air piston then forces the shank downward and thus squeezes the jaw into position. This operation is performed at the rate of about 150 couplers in eight hours. The couplers are then placed end to end on a conveyor



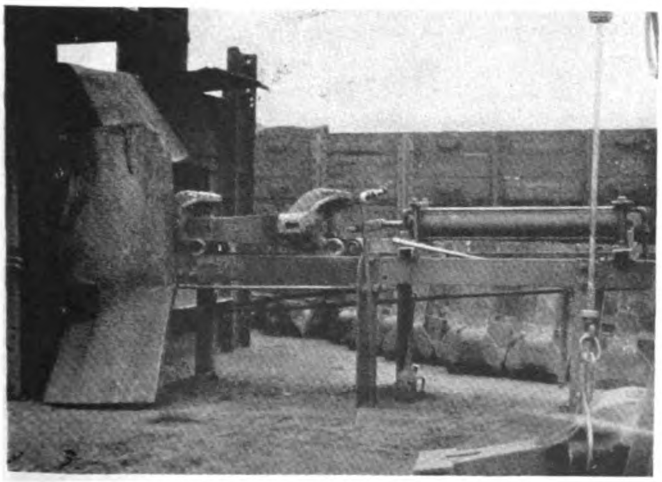
Press for straightening coupler shanks



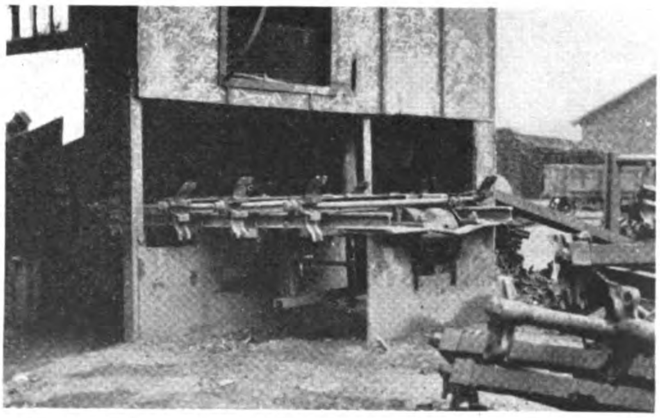
Assembling couplers and yokes



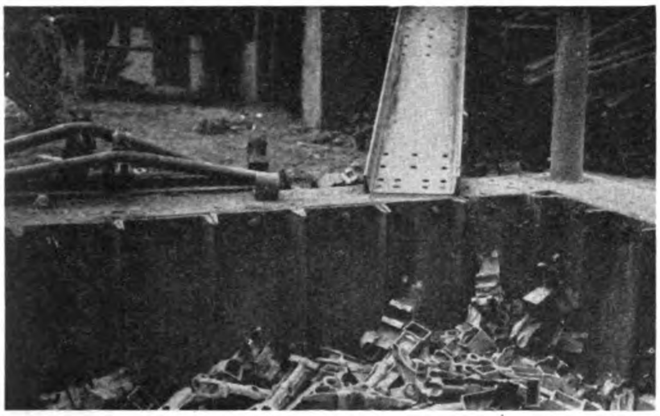
Hydraulic press for rivets, couplers and yokes



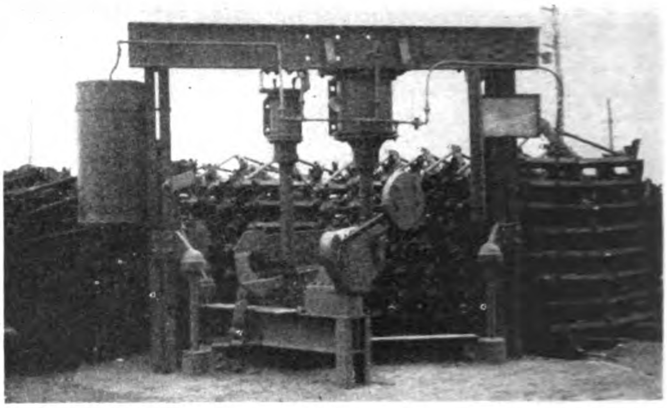
Air cylinder device for feeding couplers through the annealing furnace



A belt conveyor carries brake beams into the shop



Worn heads and fulcrums slide down a chute to an open pit outside



The brake-beam testing station and equipment

equipped with an air piston, the pressure from which pushes one coupler into the annealing furnace at one end and a thoroughly annealed coupler out of the furnace at the other end. As the red-hot coupler emerges from the furnace, it slides under an air press and the shank is straightened. The coupler is then ready for re-assembling. One man fits the yoke to the coupler and rivets the tail liner, using a bull riveter. The assembly is then placed under a rivet press, a ratchet jack applied between the end of the yoke and the coupler to assure a tight fit, and rivets inserted and pressed home. Couplers are assembled in this manner at the rate of about 170 per day.

In a separate shop, all brake beams from dismantled cars or other stations in the scrap yard are inspected and reconditioned at the rate of 320 beams a day. The beams are fed into the plant on a conveyor which was improvised from old rail, 12-in. belting and pulleys, and they are completely dismantled at the rate of 40 an hour by two men using hand-controlled compressed-air motors which are installed at each end of the dismantling bench at the end of the conveyor. All heads and fulcrums which are worn or broken beyond repair are dropped into a chute which discharges them into an open pit outside the shop from which they can be loaded into cars by a magnet. All good heads are moved to the assembly table, while others are built up to proper contour by electric welding. All nuts are taken directly to the threaders in the shop where the good nuts are re-threaded and the scrap discarded. The rods are reconditioned by recutting the threads, and all channels are straightened cold on a press. The beams are assembled with the aid of mechanical nutters and are tested in a machine made of improvised air presses. They are then stored adjacent to the shop ready for loading into cars by a gantry crane. The brake-beam crew consists of 10 men.

Conway is also equipped for rebuilding bolsters on a large scale. This operation is organized on a progressive plan under which the bolsters are moved from station to station at the rate of 35 bolsters a day, using a crew of eight men. The scrap bolsters are placed on skids made of old rail and all scrap material removed by torch. They are then passed into a completely enclosed welding shop where the bolsters are partially rebuilt and reinforced. Following this, the bolsters move out of the welding shop and the reconditioning is completed by two men.

While neither the wheel-mounting nor the truck-building operations are integral parts of the scrap and reclamation plant, being supervised by a separate organization, the truck-building operation is a noteworthy addition to the work which owes its location to the car-dismantling and car-material-reclaiming operation. The work is performed on 600 ft. of track supported 18 in. above the ground to facilitate the work. At two points rigid gallows of steel have been erected, each of which supports two side-swinging jib cranes and an overhead girder, which serve both as a trolley and a support for 4½-ton chain blocks. Mounted wheels are placed on this track by a locomotive crane and the wheels are then rolled under the gallows where new side frames are applied and the trucks assembled, using new brake beams, hangers, wearing plates, shoe keys, cotters and springs, and some reclaimed material. The present force comprises nine men who completely assemble 34 trucks a day by this method, although with the present equipment it is possible to assemble 80 trucks a day.

Reconditioning truck bolsters after welding

Station where trucks can be assembled at a rate of 80 a day

Surface Rolling Strengthens Press-Fitted Axle Assemblies

In a paper presented before the annual meeting of the American Society for Metals at Cleveland, Ohio, October 19 to 23, T. V. Buckwalter, vice-president, and Dr. O. J. Horger, research engineer of the Timken Roller Bearing Company, summarized a series of recent investigations made by the company, which indicated that:

1. A press-fit member reduces the fatigue-strength of an axle to less than half the strength of a similar axle not having a press-fitted member.
2. Surface-rolling the axle at the press-fitted section practically restores the full strength of the axle, making it possible to utilize in press-fitted assemblies practically the same strength as is available in plain axles which do not have press-fitted members.

In testing a 2-in. axle, made of S. A. E. 1045 steel, normalized and drawn, the fatigue strength of the axle in a press-fitted assembly was increased from 14,000 to 33,000 lb. per sq. in. by surface-rolling with a roll pressure of 2,400 lb. In the case of a 2.75 per cent nickle steel axle, quenched and tempered, the fatigue strength was increased from 17,000 to 38,000 lb. per sq. in. by surface-rolling the axle with a roll pressure of 400 lb.

To determine the effect of surface rolling in large axles and to secure further data relating to forging and heat-treating practice as well as on other problems associated with large sections, the Timken Roller Bearing Company is building a fatigue-testing machine capable of testing axles up to 13½ in. in diameter.

Questions and Answers On the AB Brake

Branch-Pipe Tee

96—*Q.—How is this fitting used?* A.—To connect the branch pipe to the brake pipe.

97—*Q.—What is its purpose?* A.—To prevent excessive moisture in the brake pipe from passing into the branch pipe and from passing from that pipe to the AB valve.

98—*Q.—How is this accomplished?* A.—The interior is such that the passage leading to the branch pipe comes out of the top, with the result that moisture and heavy particles of dirt pass on through the brake pipe.

99—*Q.—How is this device connected?* A.—By means of re-inforced flanged unions, and is bolted to the car underframing by means of a lug cast on the body.

Pressure-Retaining Valve

100—*Q.—What type retaining valve is used with the AB equipment?* A.—The standard for freight equipment cars, a three-position 10-20 lb. duplex spring type, having a nominal blow-down value of 50 sec. in the 10-lb. position and 90 sec. in this 20-lb. position.

101—*Q.—To what is this valve connected?* A.—To the AB valve exhaust connection in the bracket portion.

102—*Q.—Name the operating parts.* A.—Cock key and two valves and springs.

103—*Q.—How many outlets does the cock key have?* A.—Three. One to the atmosphere through the pipe tap "EXHAUST," one to the low-pressure side of the retaining valve proper, and another to the high-pressure side.

104—*Q.—What is the position of cock key handle when connection is made to the pipe tap "EXHAUST"?* A.—Down, in a vertical position.

105—*Q.—What connection is made in this position?* A.—The AB exhaust is open through the retaining-valve pipe, thence through the cock key and retaining-valve "EXHAUST" connection to the atmosphere.

106—*Q.—What is the position of the handle to retain 10 lb. in the brake cylinder?* A.—Up. In a horizontal position.

107—*Q.—What connection is then made?* A.—The AB exhaust is open through the cock key to the passage under one of the valves, and when sufficient pressure is obtained to overcome the 10-lb. spring, the valve unseats and the air passes through the vent port to the atmosphere.

108—*Q.—What is the position of handle for high pressure?* A.—Intermediate position, marked "HP."

109—*Q.—What connection is then made?* A.—The AB exhaust is open through the cock key to the passage under one of the valves which becomes unseated when the pressure exceeds 10 lb., the load value of the valve spring. The air above this valve passes through a choke to the under side of another valve which is also held seated by a 10-lb. spring. Therefore, air at 10-lb. pressure is added to the spring force of the first valve, making a total force of 20 lb. acting on this valve to keep it seated. The first valve, therefore, closes with less than 20-lb. cylinder pressure, thereby retaining this pressure. Air which passes both valves flows to the atmosphere through the choked vent port in the long valve cap.

110—*Q.—What chokes are incorporated in the retaining valve?* A.—Two. One in the passage between the two valves and the other in the vent port.

111—*Q.—What advantageous feature is incorporated with the valves?* A.—The valves and springs are permanently enclosed in the cap nuts.

112—*Q.—What is the benefit of this arrangement?* A.—It prevents a possibility of spring distortion and assures permanent closing values.

Operation of the Equipment

113—*Q.—Name the various positions of the AB valve.* A.—Full release and charging. Retarded recharge. Preliminary quick-service (consisting practically of three steps). Service (which consists of two steps). Service lap. Emergency, first, second and third stages. Release after emergency. Accelerated emergency release.

114—*Q.—What ports are open in full release and charging positions?* A.—Brake pipe to auxiliary reservoir via both feed grooves in service piston bushing. Brake pipe to accelerated-release valve chamber. Brake pipe to quick-action chamber via charging choke. Brake pipe to vent valve chamber. Brake pipe to by-pass checks. Auxiliary reservoir to emergency reservoir via service slide valve chamber through a restricted port in the service slide valve at the left end of the graduating valve. Auxiliary reservoir to release insuring valve. Auxiliary reservoir to auxiliary reservoir check in the duplex release valve. Emergency reservoir to chambers over spill-over checks and strut diaphragm. Emergency reservoir to its check in the duplex release valve. Quick action chamber to accelerated release piston chamber. Brake cylinder to atmosphere via retaining valve.

115—*Q.—What ports open in retarded recharge position?* A.—The same as in full release, with the exception that flow of air from brake pipe to auxiliary reservoir is restricted to one feed groove.

116—*Q.—What ports open in preliminary quick service position?* A.—Brake pipe to atmosphere via service graduating valve and slide valve, quick service volume

and preliminary quick service choke plug. Brake pipe to by-pass checks, to vent valve chamber, and to accelerated release check valve chamber. Auxiliary reservoir to release insuring valve and to the auxiliary reservoir check in the duplex release valve. Quick action chamber to atmosphere and to accelerated release piston chamber. Emergency reservoir to spill-over checks and strut diaphragm and to its check in the duplex release valve. Brake cylinder to atmosphere via retaining valve.

117.—*Q.—What ports open in service position?* A.—In the first step or stage of service which constitutes a quick service application, the following ports are open: Brake pipe to brake cylinder via back-flow and limiting valve checks and inshot valve. Brake pipe to vent valve chamber and to accelerated-release check valve chamber. Auxiliary reservoir to brake cylinder via service slide valve and inshot valve. Auxiliary reservoir to release insuring valve and to the auxiliary reservoir check in the duplex release valve. Quick action chamber to atmosphere and to accelerated-release piston chamber. Emergency reservoir to spill-over checks and strut diaphragm, and to the emergency reservoir check in the duplex release valve. Inshot piston volume to the chamber back of the inshot piston.

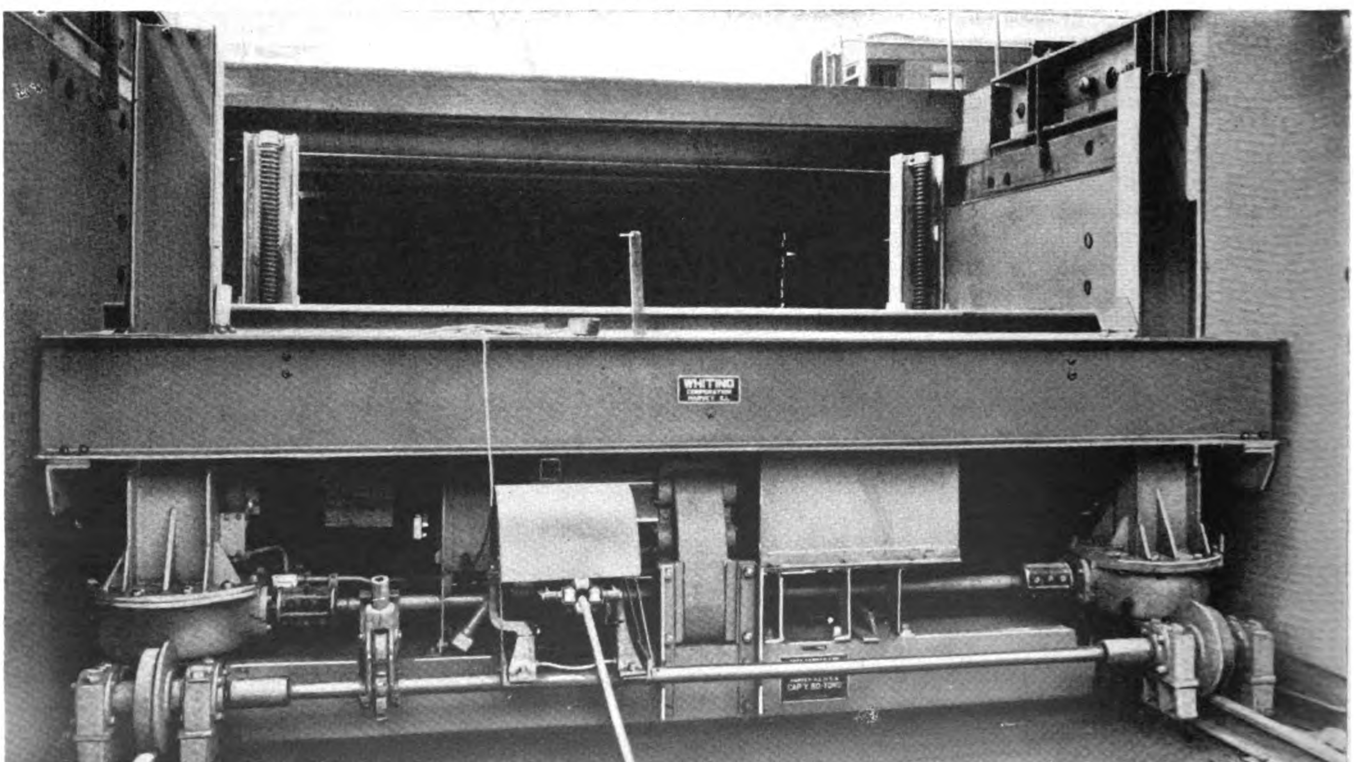
Drop Pit Table Of Improved Design

The Whiting Corporation, Harvey, Ill., has developed and is now introducing a new Model-B drop pit table which incorporates a number of changes over earlier designs, brought about largely by increased demands made upon such equipment since the introduction of streamline trains in railway service. The drop table incorporates the screw principle which has been the basic element in all Whiting locomotive and car jack equipment for the past 25 years, but improvements in detail design have been incorporated to provide such important advantages as greater rigidity, higher speeds, longer life of screws and nuts, and better accessibility for inspection and maintenance.

Instead of having a heavy superstructure raised and lowered through worm gearing, the Model-B drop table is equipped with bevel gears mounted on the truck. The table top is supported by two cross, or lifting, beams resting on bronze nuts, as in the case of beams used on Whiting locomotive hoists. The lifting beams are raised and lowered by rotating the screws. The provision of a heavy vertical H-beam around each screw supports and braces the screw at the upper end. This gives greater rigidity and, in conjunction with the use of larger diameter screws and nuts, reduces screw and nut wear and assures longer life for these parts. The screws are made of high-carbon steel with buttress threads of liberal size for the rated loads.

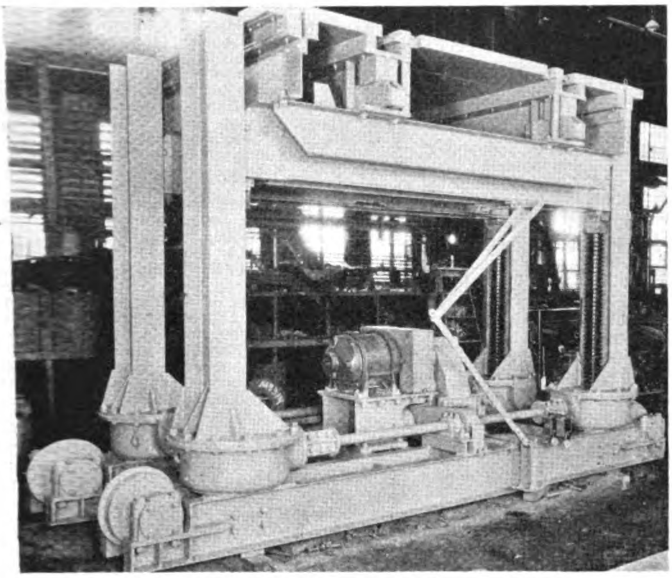
The use of bevel gears in place of worm gears permits higher hoisting speeds and with single-speed motors it is now possible to obtain hoisting speeds as high as 4 ft. per min. A herringbone-gear speed reducer, mounted on the truck in an accessible position, is provided to transmit power from the motor to the bevel gears which operate the screws. The motor and solenoid brakes are likewise mounted on the truck. The table top is of simplified construction, using a heavy single H-beam for the main support of each table top rail. Effective locking bars are provided for locking the top in position at ground level. The table is designed to accommodate either plain or compound tops.

Each of the four truck wheels is mounted between two roller bearings, pressure-lubricated and of ample size for the rated load. The table is easily racked to side position by a hand ratchet device. A motor-operated racking device is furnished, if desired, at extra cost. All of the operating machinery is mounted on the truck at a sufficient height from the pit floor to eliminate any water hazard and to make it readily accessible for inspection and maintenance.



Whiting 60-ton capacity Model-B drop-pit table with all-steel table top 18 ft. 6 in long by 13 ft. wide used to drop wheels and trucks of streamline trains

A new design of compound table top has been developed for use with either standard or Model-B Whiting drop pit tables. As shown in one of the illustrations, a small top is provided within the large one, each having its own set of locking bars and so arranged that a complete lead truck, trailer, tender or passenger-car truck can be dropped on the large and small top operating as one unit; or a single pair of wheels can be dropped on the small or inner top, with the large top locked in normal position at ground level. The compound top can also be used to handle single or multiple pairs of driving wheels.



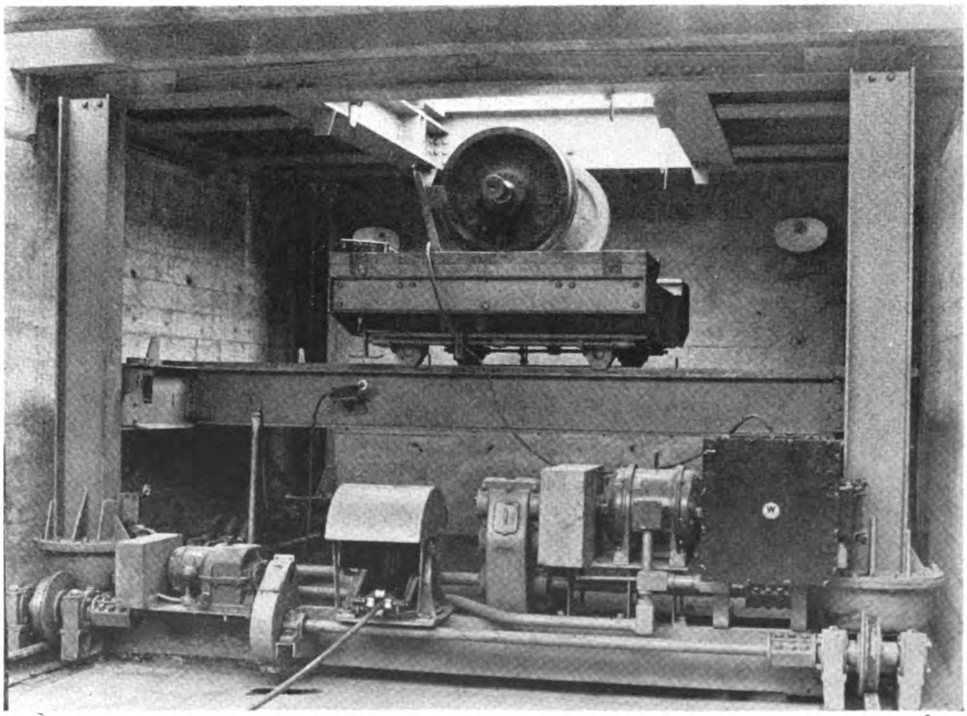
Model B 65-ton drop table for narrow pit, with drive mechanism mounted on truck within the structure—Racked through gear-head motor and equipped with spring wind-up reel—Table-top distance across the pit, 6 ft.

The new Whiting compound drop-table top consists of a large rectangular frame with the side girders, spanning the pit, made exceptionally heavy as they must support the weight of the locomotive resting on the top. These two heavy girders are equipped with four locking bars that engage pockets in the side walls of the pit. This rectangular frame has other steel cross members riveted to it to provide a well at its center into which the small table top fits. End and center cross members are connected by additional members on the upper surface of which are rails on which the equipment, whether individual car, locomotive or streamline train, can run over the large top.

The small table top consists of a steel rectangular frame with cross girders within, on the upper surfaces of which are rails coinciding with the rails of the large top for running locomotives across. The small top is also equipped with locking bars. The small table top on its under surface has four retractable wheels 6 in. in diameter that can contact with railed beams on the drop table superstructure.

When the large and small table tops are to be operated as one unit, the retractable wheels of the small top are swung into "clear." As the machine's superstructure rises, it finally contacts the large and small top simultaneously and can raise the complete assembly a short distance for release of the locking bars, or a total distance of 6 in. for doing necessary work. Later, if necessary, both tops (as one) may be lowered under load any distance that may be required by the nature of the work.

If both tops are locked in place—the large to the side walls of the pit—the small to the large top—and it is desired to drop the small top only, the retractable wheels of the small top are swung down to operative position. As the drop table's superstructure is elevated, its railed beams contact these four 6-in. wheels of the small top when still 6 in. away from the large top. It is therefore possible to raise the small top either 6 in. above the large top for certain work, or a shorter distance for release of the small-top locking bars from the large top. After this is done, the small top with its load may lower through the large top, with movement continued until clearance is obtained. After racking sidewise, the small top is raised level with the releasing track and is rolled with its load to the side wall of the pit by means of its four wheels and railed superstructure. After reaching the side wall, its locking bars engage special wall pockets to anchor the table top and keep it from tilting while the load is being rolled off.



Model B 60-ton drop-pit table with compound top—Large top locked at ground level and small top lowering a single pair of wheels

Among the Clubs and Associations

New England Railroad Club.—Hot Boxes will be the subject discussed by C. B. Smith, engineer of Tests, Boston & Maine, before the meeting to be held at 6:30 p.m., December 8, at the Hotel Touraine, Boston, Mass.

Car Foremen's Association of Chicago.—C. J. Hayes, supervisor of A. A. R. billing, New York Central, will discuss the Handling of Car Repair Bills at the meeting to be held at the LaSalle Hotel, Chicago, on December 14 at 8 p.m.

Mechanical Division, A. A. R.—The general committee of the Mechanical Division, A.A.R., and the general committee of the Purchases and Stores Division, at a meeting in New York on Thursday, decided to hold their annual convention in Atlantic City, N. J., next June. The Railway Supply Manufacturers Association will cooperate by having an exhibit. It is seven years since a joint convention and exhibit of this sort has been held.

DIRECTORY

The following list gives names of secretaries, dates of next regular meetings, and places of meetings of mechanical associations and railroad clubs:

Air-Brake Association.—T. L. Burton, care of Westinghouse Air Brake Company, 3400 Empire State Building, New York.

Allied Railway Supply Association.—F. W. Venton, Crane Company, Chicago.

American Railway Tool Foremen's Association.—G. G. Macina, 11402 Calumet avenue, Chicago.

American Society of Mechanical Engineers. C. E. Davies, 29 West Thirty-ninth street, New York.
Railroad Division.—Marion B. Richardson, 192 East Cedar street, Livingston, N. J.
Machine Shop Practice Division.—G. F. Nordenholt, 330 West Forty-second street, New York.
Materials Handling Division.—F. J. Shepard, Jr., Lewis-Shepard Co., Watertown Station, Boston, Mass.
Oil and Gas Power Division.—M. J. Reed, 2 West Forty-fifth street, New York.
Fuels Division.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

Association of American Railroads.—J. M. Symes, vice-president operations and maintenance department, Transportation Building, Washington, D. C.
Division I.—Operating.—Safety Section.—J. C. Caviston, 30 Vesey street, New York.
Division V.—Mechanical.—V. R. Hawthorne, 59 East Van Buren street, Chicago.
Committee on Research.—E. B. Hall, chairman, care of Chicago & North Western, Chicago.
Division VI.—Purchases and Stores.—W. J. Farrell, 30 Vesey street, New York.
Division VIII.—Motor Transport.—Car Service Division.—C. A. Buch, Transportation Building, Washington, D. C.

Association of Railway Electrical Engineers.—Jos. A. Andreucetti, C. & N. W., 1519 Daily News Building, 400 West Madison street, Chicago, Ill.

Canadian Railway Club.—C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

Car Department Officers' Association.—A. S. Sternberg, master car builder, Belt Railway of Chicago, 7926 South Morgan street, Chicago.

Car Foremen's Association of Chicago.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago.

Car Foremen's Association of Omaha, Council Bluffs and South Omaha Interchange.—H. E. Moran, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p. m.

Central Railway Club of Buffalo.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

Eastern Car Foremen's Association.—E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

Indianapolis Car Inspection Association.—R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

International Railway Fuel Association.—See Railway Fuel and Traveling Engineers' Association.

International Railway General Foremen's Association.—William Hall, 1061 West Wabasha street, Winona, Minn.

International Railway Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark avenue, Detroit, Mich.

Master Boiler Makers' Association.—A. F. Stiglmeier, secretary, 29 Parkwood street, Albany, N. Y. Annual meeting, September 16 and 17, Hotel Sherman, Chicago.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, except June, July, August and September, at Hotel Touraine, Boston.

New York Railroad Club.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July, August and September, at 29 West Thirty-ninth street, New York.

Northwest Car Men's Association.—E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Midway Club rooms, University and Prior avenue, St. Paul.

Pacific Railway Club.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately—June in Los Angeles and October in Sacramento.

Railway Club of Greenville.—J. Howard Waite, 43 Chambers avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

Railway Club of Pittsburgh.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

Railway Fire Protection Association.—R. R. Hackett, Baltimore & Ohio, Baltimore, Md.

Railway Fuel and Traveling Engineers' Association.—T. Duff Smith, 1660 Old Colony building, Chicago.

Railway Supply Manufacturers' Association.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Meets with Mechanical Division and Purchases and Stores Division, Association of American Railroads.

Southern and Southwestern Railway Club.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

Toronto Railway Club.—R. H. Burgess, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August, at Royal York Hotel, Toronto, Ont.

Traveling Engineers' Association.—See Railway Fuel and Traveling Engineers' Association.

Western Railway Club.—C. L. Emerson, executive secretary, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.

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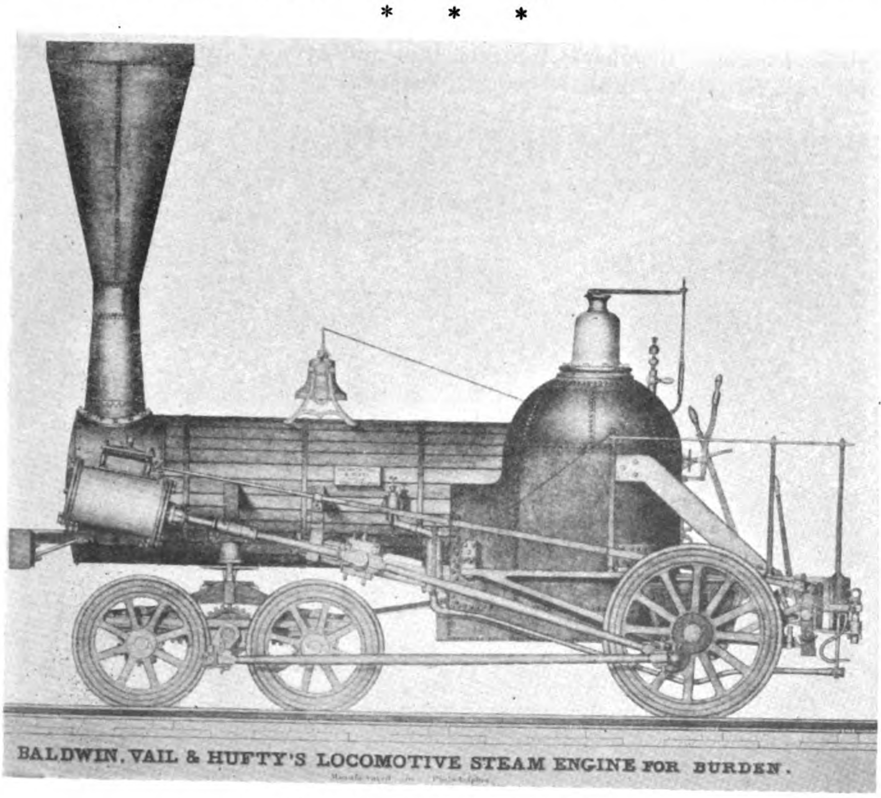

A locomotive of the decade, 1830-40

Globe photo

Through the cab window of a British locomotive

NEWS

Air-Conditioning Programs

The Union Pacific will spend a total of $500,000 in modernizing and air-conditioning 40 passenger cars in its Omaha shops.

The Nashville, Chattanooga & St. Louis will spend $123,377 on an air-conditioning program, to be carried out this fall and the early part of next year. With the completion of this program, all cars used in main line service will be air-conditioned.

The Louisville & Nashville has authorized an appropriation of $800,000 to cover its air-conditioning program of passenger cars for next year. This includes the equipping of 80 all-steel coaches and three dining cars. This work will be carried out in the railroad's South Louisville, Ky., shops as soon as possible in order to have the equipment in service early next Spring. These cars, together with the 39 coaches and 13 diners, air-conditioned by the road and the Pullman cars thus equipped, will provide completely air-conditioned service on practically every Louisville & Nashville main line train, except some locals. It does not include local or suburban service.

R. B. A. Annual Meeting

At its annual meeting in New York on November 5, the Railway Business Association re-elected its officers and executive committee, and appointive officers were re-appointed. Three new members were added to the governing board as follows: Carl C. Gibbs, president, National Malleable & Steel Castings Co.; N. J. Clarke, president, Republic Steel Corporation; J. H. Rodger, Oxweld Railroad Service Company.

At the annual dinner, preceding the address of Dr. H. G. Moulton, President Harry A. Wheeler reviewed briefly the success of the program of the association in promoting the study of the probable effects of government ownership on the railroad industry—and the great volume of public sentiment against such an eventuality which has thereby been developed.

Research and Unification Progressed During 1936

Railroad research activities "reached a new high level in 1936" and rapid progress is being made on studies of projects involving proposed co-ordination of facilities and services, according to reports made at the regular fall meeting of the Association of American Railroads, held in the Hotel Biltmore, New York, on November 6.

The review of railroad research in 1936 showed that such activities during the current year have been concerned with virtually every phase of railroad operation. Listed as "outstanding" were studies of the A.A.R. Division of Equipment Research with respect to air conditioning. The object of these studies, on which a report will soon be ready, has been to ascertain what improvements can be made in the present air-conditioning systems and what can be done toward standardizing that equipment.

Other current research activities include motive power efficiency studies of railroads and locomotive builders; experiments of individual roads, the A.A.R. and car builders to determine the extent to which steel alloys are practical for passenger and freight cars; experiments of manufacturers in connection with fusion welding of tank cars; studies designed to improve brake shoes, and the draft gear tests at Purdue University.

In connection with the co-ordination studies it was pointed out that 48 have been completed, 10 of which are now being put into effect. In addition, 673 projects are being re-examined in the light of changed labor and traffic conditions.

Western Pacific 1937 Improvement Program

The Western Pacific, following approval by the federal district court on October 28, will spend $7,000,000 for improvements to road and equipment and for the purchase of new locomotives and freight cars in 1937. Of the total $4,465,955 is for improvements to road and equipment and $2,605,000 is for the purchase of new locomotives and freight cars. These expenditures authorized by the court represent the second phase of a three-year program of improvements which was initiated shortly after the beginning of this year and which will involve an ultimate aggregate outlay of more than $14,000,000 for improvements and new equipment. It is expected that this improve-

(*Turn to next left-hand page*)

ment program will be completed during 1938.

The 1937 improvement program in part is as follows:

Engine terminal improvements, installation of additional stalls with drop pits, and enlarged turntables at Oroville, Cal., Elko, Nev. and Wendover, Utah $266,068

Heavy repairs and improvements to equipment include:

The substitution of steel sides and doors for wooden sides and doors on 100 box cars $149,300

The installation of Evans loaders on 50 automobile cars $49,500

Repairs to 500 box cars.......... $200,000

Conversion of 100 forty-foot box cars into single-deck stock cars.............. $36,000

Conversion of 100 thirty-six-foot single-deck stock cars into double-deck cars. $14,000

The substituting of cast steel side frames for arch bar trucks on 2,520 freight cars $525,033

The modernizing of passenger cars and the installation of air-conditioning equipment $39,817

The installation of modern economy and efficiency devices on locomotives.... $25,000

Additional tools and appliances for the company's general shops at Sacramento, Cal., and for various enginehouses........ $105,000

Expenditures for new motive power and new equipment include:

The purchase of seven 4-6-6-4 high-speed freight locomotives for service in Nevada and Utah, and four 2-8-8-2 type locomotives for service in the Feather River Canyon, Cal. $1,580,000

The purchase of two hundred 40-ft., 50-ton box cars; fifty 50-ft., 50-ton flat cars; 100 hopper cars and one 200-ton wrecking crane $1,025,000

New Equipment

Locomotive Orders

Road	No. of locos.	Type of loco.	Builder
Aluminum Co. of America	1	600-hp. Diesel-elec.	American Loco. Co.
C. B. & Q.	10[1]	Either frt. or pass. serv.	Company shops
	1[1]	Streamline steam	Company shops
C. M. St. P. & P.	30[2]	4-8-4	Baldwin Loco. Works
	1[2]	Hiawatha	American Loco. Co.
C. R. I. & P.	6[3]	1,200-hp. Diesel-elec.	Electro-Motive Corp.
New York Central	50[4]	Hudson	American Loco. Co.
	50[4]	8-wheel switchers	Lima Loco. Works
Norfolk & Western	8	Freight	Company shops
Union Pacific	20[5]	4-8-4	American Loco. Co.
Utah Copper Co.	12	85-ton elec.	General Elec. Co.
W. & L. E.	10[6]	2-8-4	American Loco. Co.

Locomotive Inquiries

B. & L. E.	10	Texas, frt.	
	2	8-wheel switchers	
D. L. & W.	5	4-6-4 pass.	
Union R. R.	4	10-wheel switchers	
Western Maryland	10	2-6-6-4	

Freight Car Orders

Road	No. of cars	Type of car	Builder
C. & E. I.	500[7]	50-ton box	Gen. Amer. Trans. Corp.
C. R. I. & P.	350[8]	50-ton auto.	American Car & Fdry. Co.
G. M. & N.	300	50-ton box	American Car & Fdry. Co.
Norfolk & Western	500	Gondolas	Company shops
	500	Hopper	
Union Pacific	300	Underframes[9]	Mt. Vernon Car Mfg. Co.
Western Maryland	500	50-ton box	Bethlehem Steel Co.
	100	50-ton gondolas	

Freight Car Inquiries

B. & L. E.	1,000	90-ton hopper	
	500	70-ton hopper	
	500	50-ton gondolas	
C. & O.	1,000	50-ton hopper	
	500	50-ton box	
	500	50-ton gondolas	
D. M. & N.	250, 500, or 1,000	70-ton ore	
	50	75-ton hopper	
C. & N. W.	350-500	70-ton hopper	
E. J. & E.	750	50-ton gondolas	
	100	70-ton gondolas	
	200	50-ton gondolas	
Norfolk & Western	1,000	Hopper	
Norfolk Southern	25	40-ton auto.	
Union R. R.	900	70-ton gondola	
Virginian	25	50-ton auto. box	
Warrior River Ter. Co.	20	40-ton box	
Western Pacific	200	50-ton box	

Passenger Car Orders

Road	No. of cars	Type of car	Builder
C. R. I. & P.	20[3]		Edward G. Budd Mfg. Co.
Union Pacific	40[10]	Coaches	Pullman Std. Car Mfg. Co.
	5[10]	Diners	
	5	Kitchen-dormitory	

[1] These 11 locomotives to cost more than $1,000,000.

[2] Orders subject to approval of the Federal Court and the I. C. C.

[3] These locomotives will be used to haul four three-car trains and two four-car trains, the twenty cars for which have been ordered from the Edward G. Budd Mfg. Co. The cars will be of conventional size and shape, except the last car of each train which will be of streamline design to provide a solarium observation lounge. Each train will be partly articulated, the three-car trains riding on five trucks and the four-car trains on six trucks. The trains will be air conditioned throughout, and will provide accommodations for 120 passengers in coach sections; 26 in observation lounge, and 16 in dinette, the four-car trains each having 60 additional seats in the extra coach.

[4] These 100 locomotives which are for delivery early next year, will cost approximately $8,600,000.

[5] To cost approximately $3,000,000.

[6] To have 25-in. by 34-in. cylinders and a total weight in working order of 431,000 lb.

[7] Authorized by federal district court at Chicago.

[8] Subject to approval of the court.

[9] For 300, 50-ft. automobile cars to be built in company shops. $1,500,000 will be spent by the Union Pacific for car rehabilitation and construction in company shops.

[10] The cost of the 40 coaches and 5 diners for use on the Challenger, is estimated at $3,500,000. The diners are to be of the coffee-shop type.

Letter Ballot Returns

The recommendations of various committees reporting at the Mechanical Division meeting held at Chicago, June 25 and 26, were ordered submitted to a letter ballot, the results of which have just been made available. These recommendations comprised a total of 99 propositions, divided between the various committees as follows: Brakes and Brake Equipment, 5; Car Construction, 6; Couplers and Draft Gears, 6; Air Conditioning and Equipment Lighting, 1; Loading Rules, 55; Locomotive Construction, 4; Lubrication of Cars and Locomotives, 1; Specifications for Materials, 14; Tank Cars, 4; Wheels, 3. All of these propositions to amend the standard and recommended practice of the Mechanical Division have been approved effective March 1, 1937, with the exception of proposition No. 5 covering Specifications for Repairs to Freight Equipment Brake Beams, which is approved effective January 1, 1937, and proposition No. 10 covering Definition and Designating Letters, which is approved effective immediately. Also, the proposition to amend the Loading Rules of the Division are approved, effective January 1, 1937. Detailed information regarding this letter ballot is made available in the Mechanical Division's circular No. D. V. —885 just issued by Secretary V. R. Hawthorne.

P. W. A. Railroad Loans Net Profit to Government

Public Works Administration loans, $200,529,000 to 32 railroads for rolling stock, motive power, modernization and improved plant, made possible work-producing construction and resulted in a profit of $3,218,247 to the Public Works Administration from the sale of a portion of the bonds and securities accepted by it to cover the loans, according to a special report made by the Accounting Division to Administrator Harold L. Ickes.

PWA's loans enabled the 32 railroads to construct and purchase three high-speed streamlined trains, 195 locomotives, 303 passenger cars, 36 mail and express cars which went to make up a number of other well-known high-speed trains; and 24,170 freight cars. It also enabled the repair and reconditioning of 1,928 locomotives, 947 passenger cars, 40,877 freight cars, and the equipment of 300 freight cars with automatic loaders. Considerable reconstruction of roadbeds, bridges, culverts, and other structures also took place, including completion of the electrification of the Pennsylvania from New York to Washington.

The PWA Division of Transportation Loans, organized in the fall of 1933, has been abolished by PWA. The personnel has been transferred to RFC.

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Supply Trade Notes

W. W. WILLIAMS, general sales manager of the Babcock & Wilcox Tube Company, Beaver Falls, Pa., has been appointed general manager of the company, and T. F. Thornton, sales manager of the Detroit office district, has been appointed general sales manager.

THE SYMINGTON COMPANY, Rochester, N. Y., has changed its corporate name to The Symington-Gould Corporation and acquired the entire capital stock of The Gould Coupler Corporation (formerly The Gould Coupler Company). No change is contemplated in the policies, management or business operations of either company.

HAROLD BYRON SMITH has been elected president of the Shakeproof Lock Washer Company, Chicago, to succeed his father, the late Harold C. Smith. The other officers of the company are as follows: Frank W. England and Carl G. Olson, vice-presidents; Calmer L. Johnson, secretary and treasurer; Frank W. England, assistant secretary.

FERDINAND A. KEIHN has resigned his position as manager—Contract and Specification department of the J. G. Brill Company, Philadelphia, Pa., to establish his own business in the Rialto building in San Francisco, Calif. He represents several manufacturers whose products are sold to the railway industry. Mr. Keihn was associated with the International Motor Company (Mack trucks) for five years as designing engineer and later as special sales representative. The following twelve years he was employed by the J. G. Brill Company successively as sales engineer, New England sales representative, and manager.

THE ELECTRO-MOTIVE CORPORATION, LaGrange, Ill., a subsidiary of the General Motors Corporation, has awarded a contract to the Austin Company, Cleveland, Ohio, for a 504-ft. extension to the main erection and machine-shop bays. This extension will complete the original plans for this part of the plant's development which has been held up pending operating experience in the initial unit which was finished in January, 1936, and provides approximately 84,000 sq. ft. of additional plant capacity. Work will be begun at once so as to make the additional plant space available for operation early in the spring. The expenditure contemplated for building and equipment is $750,000.

GEORGE B. CUSHING, who in 1931 organized a technical promotion group now known as the engineering service department of the A. M. Byers Company, Pittsburgh, Pa., has been appointed manager of sales promotion. Mr. Cushing joined the A. M. Byers Company in 1928 to organize and head its present advertising department. B. D. Landes, who has been in the technical group since its inception, has been appointed manager of the engineering service department. T. C. Winans, in the advertising department since 1930, has been appointed advertising manager. Both the manager of the engineering service department and the advertising manager become a part of the newly formed sales promotion group headed by Mr. Cushing. R. H. Gardner, formerly of the Washington, D. C., office of the company, has been appointed manager of pipe sales and will take over all sales management duties in connection with wrought iron and steel tubular products.

NORMAN B. JOHNSON has been appointed assistant chief engineer in charge of mechanical engineering for all plants of the Pullman-Standard Car Manufacturing Company, Chicago. Mr. Johnson entered the employ of Armour & Company

Norman B. Johnson

in 1905, after which he was associated with the Chicago Railway Equipment Company from 1906 to 1909, and the American Car & Foundry Company at its Chicago plant from 1909 to 1916. In March, 1916, he became an engineer for the Haskell & Barker Car Company, and shortly thereafter was appointed chief draftsman, which position he held until November, 1919, when he went to France in connection with export war equipment. On his return in 1921 he became assistant superintendent of the Michigan City plant of Haskell & Barker, which position he held until 1928, when he was promoted to production superintendent of the same plant but of the successor company, the Pullman Car & Manufacturing Corporation, which later became the Pullman-Standard Car Manufacturing Company. He held the latter position until May, 1935, when he was transferred to the Pullman Car Works on special duty.

JULIUS KINDERVATER, former manager of the Alco plant of the American Locomotive Company at Richmond, Va., has been appointed resident manager of the Diesel Engine plant of the American Locomotive Company at Auburn, N. Y., and H. W. Bliss has been appointed manager of the Alco plant at Richmond, Va. Mr. Bliss formerly was superintendent of this same plant.

Julius Kindervater is a native of Richmond, Va., where he attended public and high schools, and, for four years, Virginian Mechanics Institute Night School of Technology. He entered the Richmond Locomotive Works in January 1891, where he served four years as machinist apprentice, and then four years as draftsman apprentice. After three years in the drawing room on detail and elevation works he became general machine shop foreman, later maintenance engineer, which position he held until 1918 when he was transferred to the New York office as mechanical superintendent of the company. After three and one-half years in New York, Mr. Kindervater went back to Richmond as manager of the Alco plant.

H. W. Bliss was born in Providence, R. I., and after graduation from the public schools, took up a mechanical career with the Coleman Horse Shoe Nail Co., Pawtucket, R. I., where he remained for about 11 years. He then went with the Schoefield Manufacturing Co., builders of woolen machinery, engaged in sales and experimental work. Soon afterwards he became associated with the American Locomotive Company at Providence, builders of the Alco automobile, and progressed until he became chief inspector. He then served as a general foreman of the machine shop until the closing of the plant. He later re-entered the employ of the American Locomotive Company at Richmond and was sent to the E. W. Bliss Company to supervise the manufacture of machinery for the cartridge case department, later returning to Richmond as Night foreman. He then went to Eddystone Munitions Company as general superintendent in the cartridge case department, and subsequently went to Kansas City, Mo., as superintendent of the Brass & Metal Company, makers of small arms munition. Returning to the Richmond plant of the American Locomotive Company he was engaged on shell contracts. On completion of this work he became night foreman of locomotive building and later assistant superintendent. He was then transferred to the Alco Accessory plant as general foreman and subsequently became superintendent.

Obituary

H. DURANT CHEEVER, chairman of the board of the Okonite Company, and president of the Okonite-Callender Cable Company, died of apoplexy in Paris, France, on October 23. Mr. Cheever had been chairman of the board of the Okonite Company for 10 years, and president for 20 years before that. He was a graduate of Harvard University (1888).

ROY E. CARTZDAFNER, chief engineer and purchasing agent of the Magor Car Corporation, died suddenly on November 12, at his home in Passaic, N. J. Mr. Cartzdafner was born at Somerville, Ohio, in 1883 and was a graduate of the Ohio State University. He was connected with the Kilbourne & Jacobs Manufacturing Company until 1916, when he entered the service of the Magor Car Corporation as chief engineer and later was appointed also purchasing agent.

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Personal Mention

General

B. M. Brown, chief assistant superintendent of motive power and equipment of the Texas & New Orleans, has been appointed assistant general superintendent of motive power of the Pacific lines of the Southern Pacific, with headquarters at San Francisco, Cal.

F. R. Hosack, master mechanic of the Gulf Coast Lines (part of the Missouri Pacific Lines) at Kingsville, Tex., has been appointed acting mechanical superintendent of the Missouri Pacific, with headquarters at St. Louis, Mo., to succeed W. H. McAmis, who has been granted a leave of absence.

F. J. Jumper, assistant general mechanical engineer of the Union Pacific, has been appointed acting general mechanical engineer, with headquarters as before at Omaha, Neb., succeeding A. H. Fetters, who has retired.

J. S. Netherwood, assistant superintendent motive power and equipment of the Southern Pacific at Algiers, La., has been transferred to Houston, Tex., and the position of assistant superintendent motive power and equipment at Algiers as well as that of chief assistant superintendent motive power and equipment at Houston, which has been held by B. M. Brown, have been abolished.

Master Mechanics and Road Foremen

J. W. Leonard has been appointed assistant master mechanic of the Philadelphia division of the Pennsylvania, with headquarters at Harrisburg, Pa.

J. E. Frels, roundhouse foreman of the Southern Pacific at Yoakum, Tex., has been appointed master mechanic at Ennis, Tex., to replace W. Donohue.

F. L. Carson, master mechanic of the San Antonio division of the Southern Pacific, with headquarters at San Antonio, Tex., has had his jurisdiction extended to include the Victoria division.

A. O. Geertz has been appointed assistant master mechanic of the Middle division of the Pennsylvania, with headquarters at Altoona, Pa.

E. A. Burchiel, road foreman of engines of the Pennsylvania at Ft. Wayne, Ind., has been appointed road foreman of engines of the Grand Rapids division, with headquarters at Grand Rapids, Mich.

T. Olson has been appointed master mechanic of the Chicago Great Western, with headquarters at Oelwein, Iowa, succeeding J. S. Morris, who has been assigned to other duties.

H. D. Allen, road foreman of engines of the Grand Rapids division of the Pennsylvania at Grand Rapids, Mich., has been appointed road foreman of engines of the Ft. Wayne division, with headquarters at Ft. Wayne, Ind.

Shop and Enginehouse

W. Donohue, master mechanic of the Southern Pacific Lines in Texas and Louisiana, with headquarters at Ennis, Tex., has been appointed superintendent of shops, with headquarters at Algiers, La.

Car Department

C. G. Tolbert, car foreman of the Norfolk & Western at Kimball, W. Va., has been promoted to the position of foreman of the Buchanan branch, with headquarters at Weller Yard.

C. A. Hensley, gang leader of the Norfolk & Western at Wilcoe, W. Va., has been promoted to the position of car foreman, with headquarters at Kimball, W. Va., succeeding C. G. Tolbert.

Purchasing and Stores

A. W. Hix has been appointed to the newly created position of assistant to the chief purchasing and stores officer of the Chesapeake & Ohio, the New York, Chicago & St. Louis and the Pere Marquette, with headquarters at Cleveland, Ohio.

Obituary

N. Dysert, general car inspector of the Missouri Pacific at Little Rock, Ark., died on August 29.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

Centrifugal Pumps.—The Worthington Pump and Machinery Corporation, Harrison, N. J., has issued a bulletin descriptive of centrifugal pumps for railroad car air conditioning.

Garlock Klozure Oil Seal.—A 40-page illustrated booklet descriptive of the characteristics, installation and general applications of the Garlock Klozure oil seal has been issued by the Garlock Packing Company, Palmyra, N. Y. Tables of standard Klozure sizes indicate the shaft sizes most commonly used with the bore diameters shown.

Cummins Engines.—Among the new booklets released by the Cummins Engine Company, Columbus, Ind., dealing with Diesel engines is an attractively illustrated bulletin which describes fuel injection systems and the difference between the individual pump of the high-pressure type and the Cummins low-pressure distributor type of fuel pump.

Heat Transfer Surfaces.—Bulletins Nos. 536 and 636, respectively, issued by the Young Radiator Company, Racine, Wis., describe Young radiators and heat transfer products and surfaces for air conditioning and special applications.

Burnishing Rollers.—The Haynes Stellite Company, a unit of the Union Carbide and Carbon Corporation, Kokomo, Ind., has issued a four-page illustrated folder describing the advantages of burnishing railroad car-axle journals, locomotive driving axle journals, piston rods, crank pins, etc., with Haynes Stellite rollers.

Odor Adsorbers.—"Consolidated Odor Adsorbers in Air Conditioning" is the title of an eight-page booklet published by the Consolidated Air Conditioning Corporation, 114 East Thirty-second street, New York. The booklet covers the question of cost of operating an air-conditioning system and stresses the necessity of reducing the amount of "make-up" air. Tables show the savings effected by reducing the amount of make-up air.

Operator's Instruction Book.—This instruction book, distributed by the Landis Machine Company, Waynesboro, Pa., gives detailed data covering the care and operation of standard pipe-threading and cutting machines, as well as the Landis receding chaser pipe-threading and cutting machine. It also contains complete information regarding the grinding and setting of chasers for use in these die heads and machines.

Diesel-Electric Trains.—Publication GEA-1928, issued by the General Electric Company, Schenectady, N. Y., contains pictures and performance features of seventeen high-speed Diesel-electric trains now operating in the United States. The pamphlet outlines the history of high-speed Diesel-electric rail transportation from the advent of the original Burlington Zephyr in 1934, and includes descriptions of the Flying Yankee, the Abraham Lincoln, the Green Diamond, the Super Chief, the City of Los Angeles, City of San Francisco, City of Denver and the later Burlington Zephyrs.

Vanadium Steels for Locomotive and Car Construction.—In its review of vanadium steels for locomotive and car construction the Vanadium Corporation of America, 420 Lexington avenue, New York, covers specific applications of carbon-vanadium steel (forgings and castings); nickel-vanadium steel (castings); chromium-vanadium steel (elliptic springs); silicon-vanadium steel (helical springs), and manganese-vanadium steel (forgings and castings, plates and shapes, rivets and engine bolts). The tensile properties for each type of steel under recommended methods of heat treatment are given and the relationship of these properties to the applications suggested is discussed. Bound with the text are detailed specification sheets covering standards of manufacture, heat treatment, chemical composition, testing and inspection for the fourteen classifications of vanadium steels recommended for application in locomotive and car construction.

This Pipe has shed its Scale

. . . *two hands full!*

NATIONAL *Scale Free* PIPE

"It's Spellerized"

NATIONAL Scale Free Pipe is exactly what the name implies . . . *pipe free of mill scale* — clean and smooth inside as well as out.

In all National butt-welded Pipe (Sizes ½ inch to 3 inches) a special process invented and developed by National Tube Company mechanically removes the welding scale from both interior and exterior. The pipe reaches you smooth and clean. No scale is left to clog small orifices, to injure meters, or otherwise interrupt service. Damage to valves is prevented. By getting rid of mill scale, which is strongly electro-negative to pipe metal, we eliminate the prime source of corrosion, pitting, and pipe deterioration. That is why National Scale Free Pipe lasts longer in service, maintains its ability to deliver full capacity, keeps pipe line maintenance low, makes repairs to costly equipment unnecessary.

National Scale Free Pipe is strong and ductile, threads well, flanges readily, coils and bends satisfactorily. It is uniform in metallic structure, in diameter and wall thickness. Thorough testing and inspection assure its high quality.

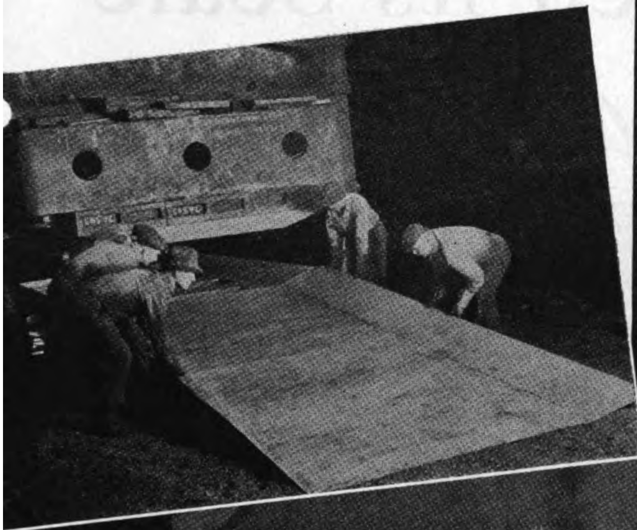
NATIONAL TUBE COMPANY

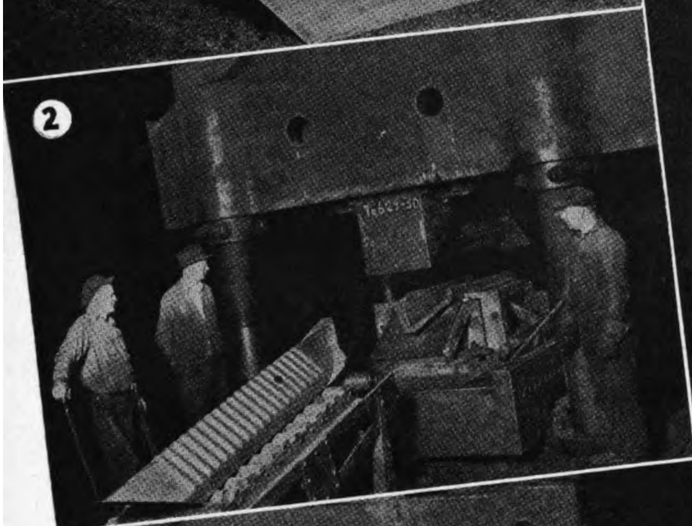
PITTSBURGH, PA.

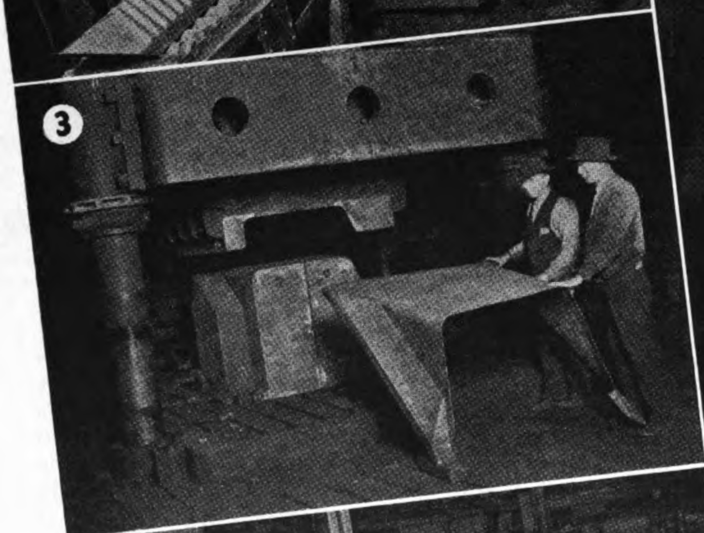
Columbia Steel Company, San Francisco, *Pacific Coast Distributors* • United States Steel Products Company, New York, *Export Distributors*

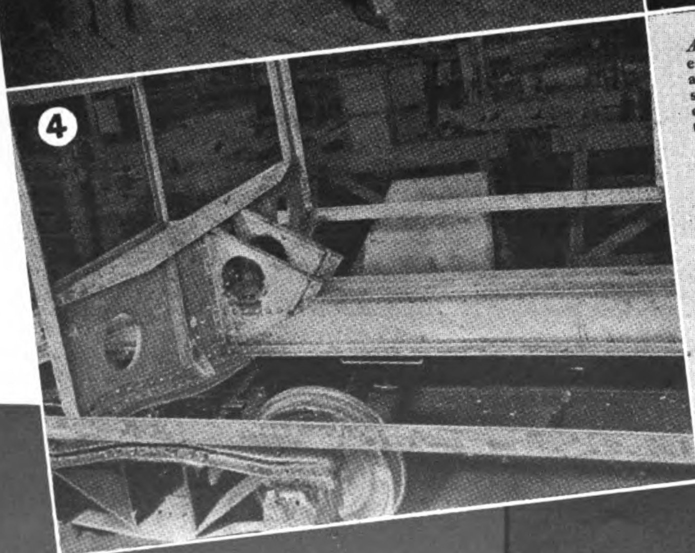
UNITED STATES STEEL

Yes . . .









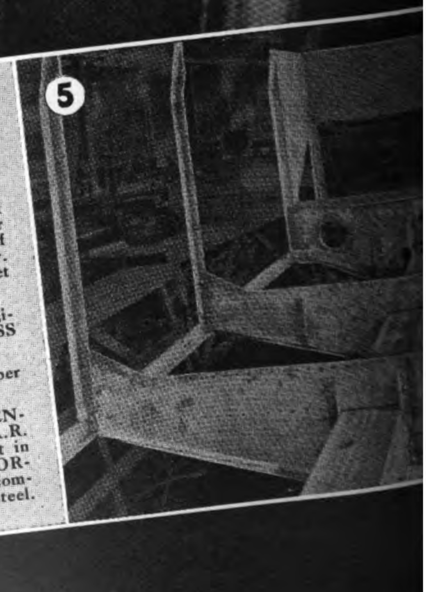
Above—USS COR-TEN can be welded by the usual shop methods. For most applications any mild steel electrode is satisfactory. For extremely corrosive conditions a coated COR-TEN electrode is available.

1—Drawing operation for forming half of the two-piece side for a hopper car from USS COR-TEN sheets. Two of these sheets form the side of the car. Slight buckles are pressed into the sheet at four locations to increase rigidity.

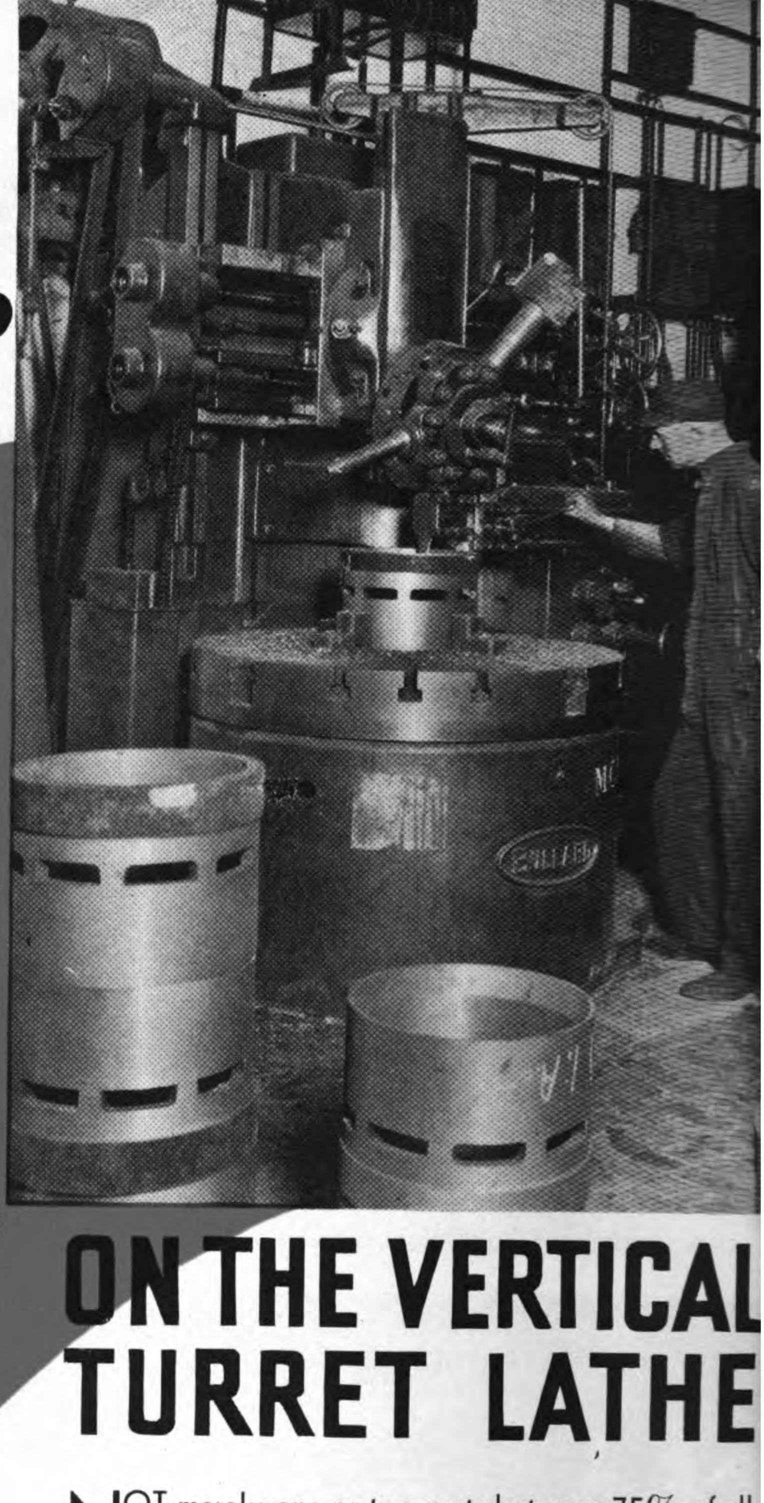
2—Hot pressing a corrugated longitudinal hood for hopper car in USS COR-TEN.

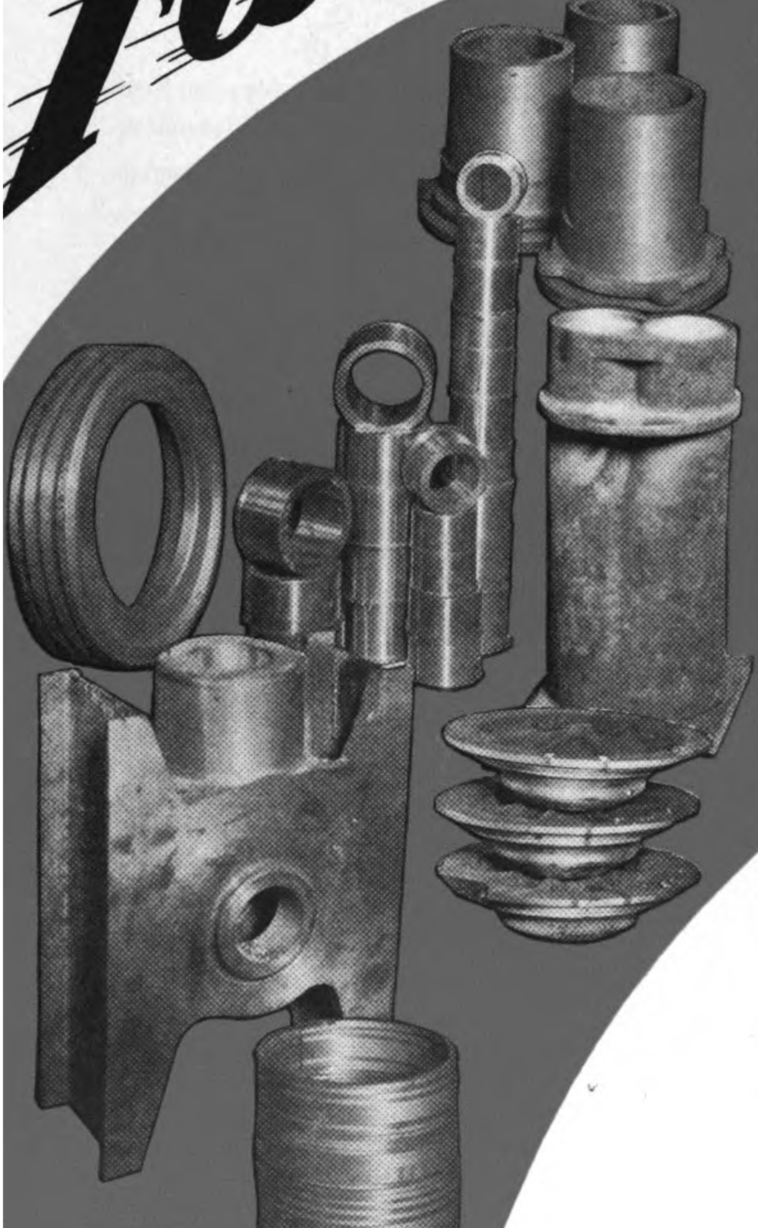
3—Cold pressing a one-piece hopper chute in USS COR-TEN.

4 and 5—Frame of USS COR-TEN-built hopper car, showing new A.A.R. double Z-section center sill, built in reduced Z-section with USS COR-TEN, weighing 62.8 lb. per foot as compared to 72.4 lb. per foot in mild steel.



50% Faster





ON THE VERTICAL TURRET LATHE

NOT merely one or two parts but over 75% of all boring and turning jobs machined in a railway shop.

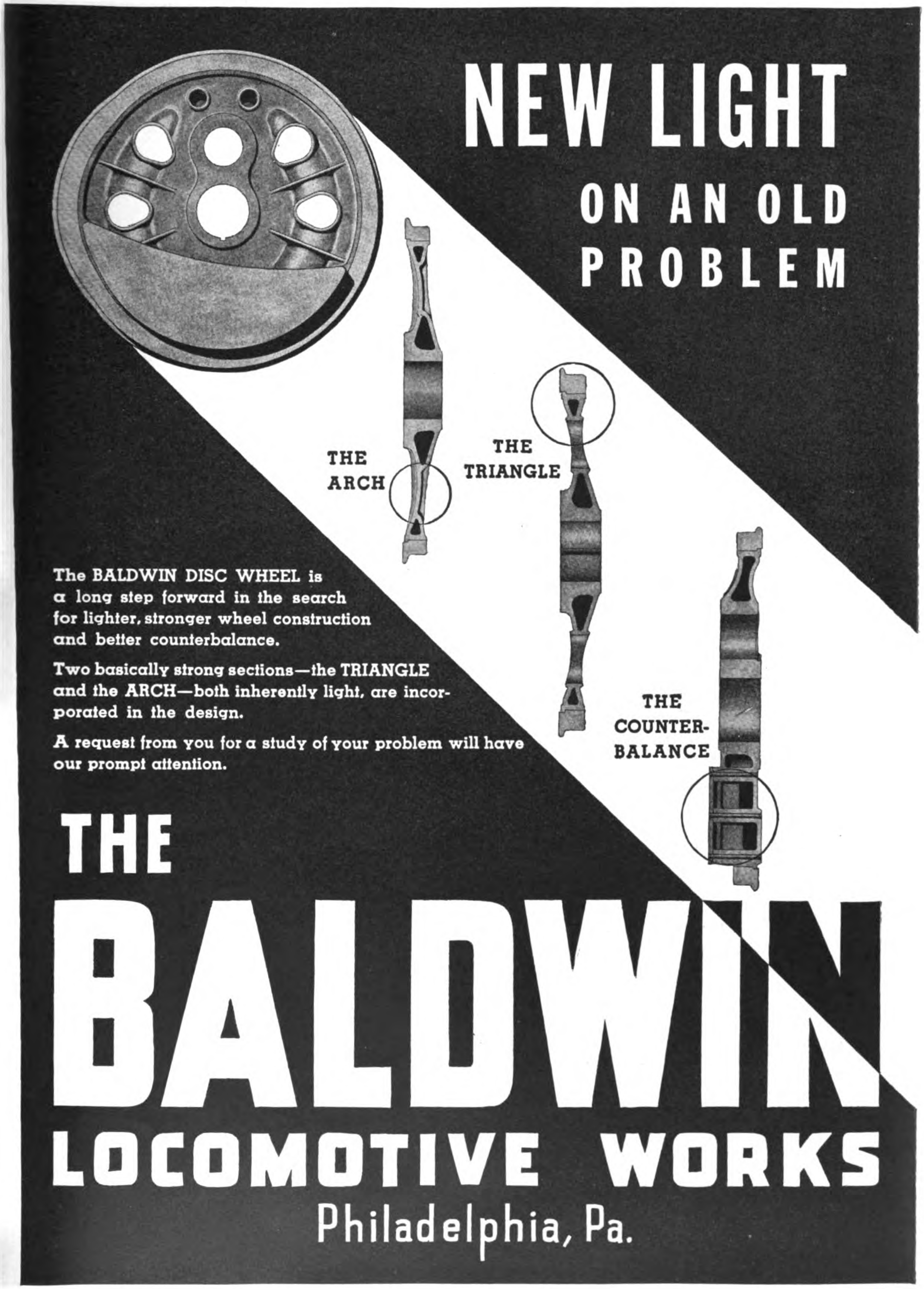
BULLARD production and BULLARD versatility make the Vertical Turret Lathe an indispensable unit. It can be kept busy, saving money when other tools are idle.

Multiple tooling—multiple cutting—correct engineering—superior materials and expert workmanship are the outstanding features.

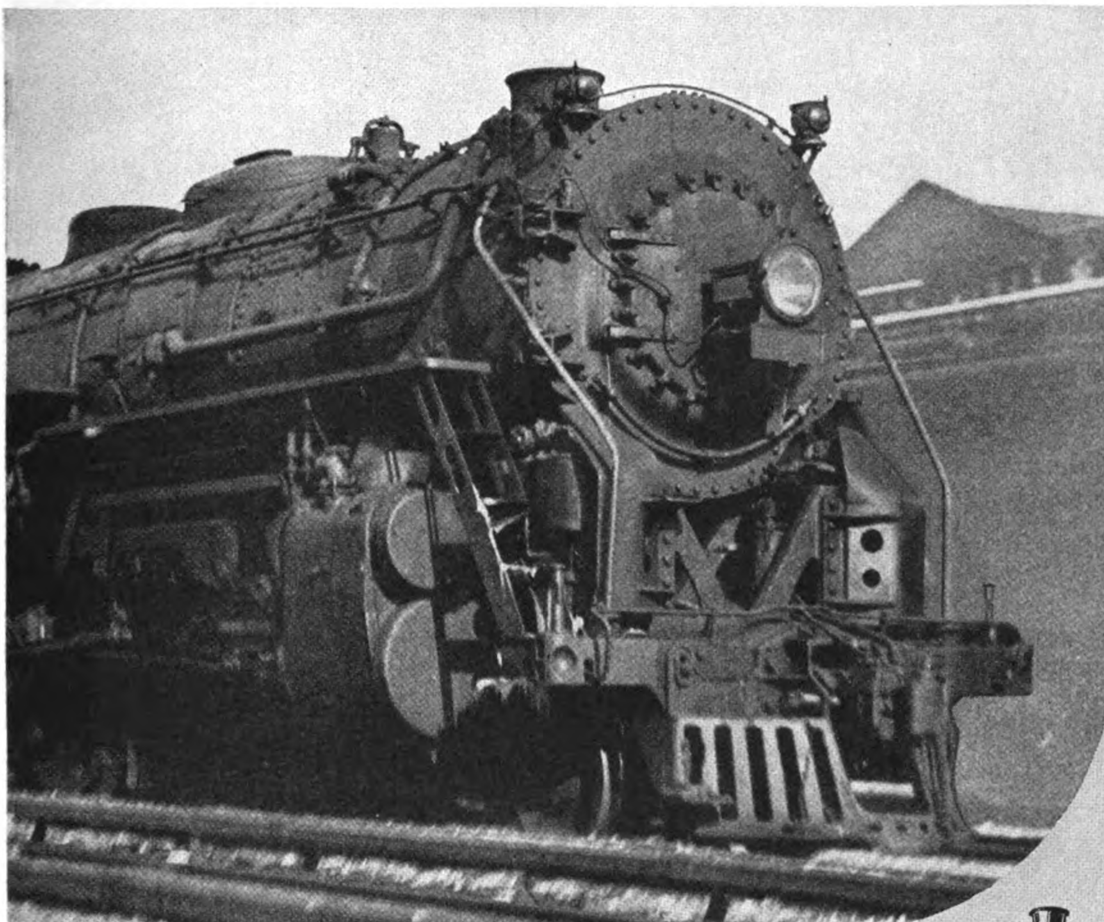
It's a veteran railroader—designed for the job—built for the job and fast on the job. Be sure to figure on a sufficient number of Vertical Turret Lathes in your shop modernization program.

THE BULLARD COMPANY

BRIDGEPORT, CONNECTICUT


NEW LIGHT
ON AN OLD
PROBLEM
THE
ARCH
THE
TRIANGLE
THE
COUNTER-
BALANCE
The BALDWIN DISC WHEEL is a long step forward in the search for lighter, stronger wheel construction and better counterbalance.
Two basically strong sections—the TRIANGLE and the ARCH—both inherently light, are incorporated in the design.
A request from you for a study of your problem will have our prompt attention.
THE
BALDWIN
LOCOMOTIVE WORKS
Philadelphia, Pa.

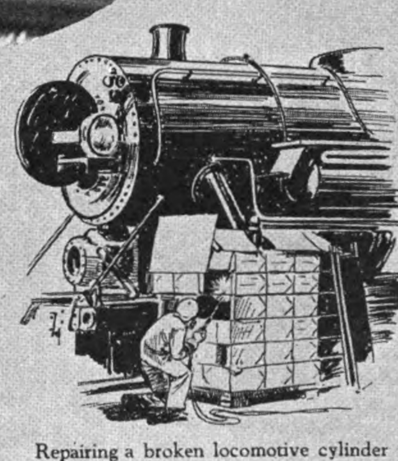
OXWELD REPAIRS on cylinders *restore* locomotives to service *promptly*



OXY-ACETYLENE welding of locomotive cylinders under Oxweld Railroad Service procedures is resulting in profits for the railroads. It shortens shop delays and restores damaged locomotives to service at low cost.

Welds in either cast-iron or cast-steel cylinders can be made by oxy-acetylene welding. Special Oxweld welding rods and welding apparatus, together with Oxweld supervision which follows closely at every step of the work, insure the high quality performance of welded cylinders.

Oxweld Railroad Service brings to railroad shops the advantages of a most unique coordination of scientific research with manufacturing and service facilities. Through these benefits for almost a quarter of a century The Oxweld Railroad Service Company has served the welding and cutting needs of a majority of the Class I railroads.



Repairing a broken locomotive cylinder by the Oxweld process makes the cylinder like new.

OXWELD RAILROAD SERVICE

THE OXWELD RAILROAD SERVICE COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

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Of course you wouldn't give Wyandotte as a Christmas present to your family or friends. But while you're enjoying a Merry Christmas in your home don't forget to give your business a Christmas present, too. Give it Wyandotte, and your business, and you, will enjoy a Happy and Prosperous New Year.

SEASON'S GREETINGS

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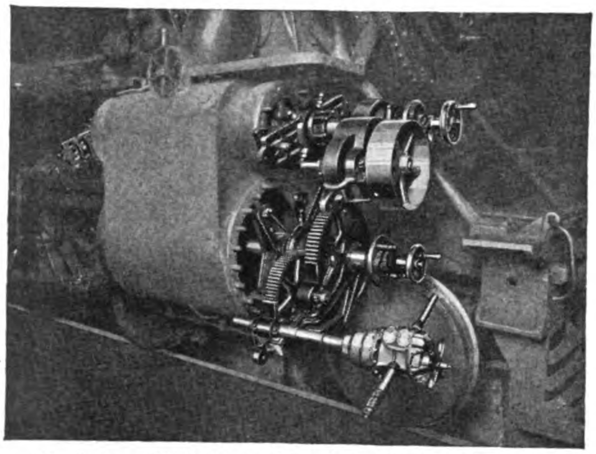
You Need These Tools and



Boring cylinders and valve chambers with UNDERWOOD Portable Boring Bars are simple and economical operations. The work is done quickly, easily and with complete accuracy. Locomotives can be returned to revenue service at once.

Your Road Needs the Savings

WHY waste any more time and money repairing those old obsolete portable tools which require hours for set-up and careful nursing during the machining operation?

The savings offered by UNDERWOOD Portable Tools will quickly pay for the replacement.

Why not check up on the condition of your units—the cost of repairs and the time required for each job? Then write us for performance data. Comparison of figures will prove to you that replacement should be started immediately.

H. B. UNDERWOOD CORP.

Philadelphia, Pa.

Valve Chamber Boring Bars
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Crank Pin Turning Machines
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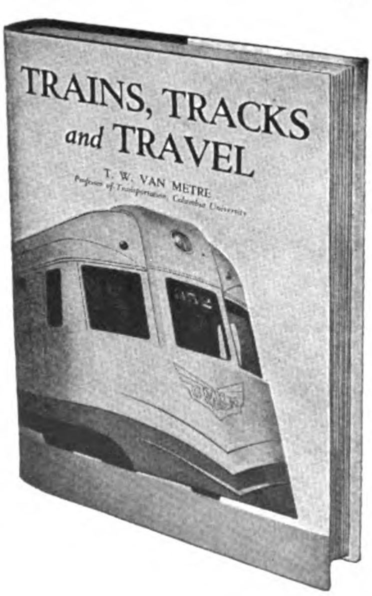
PORTABLE TOOLS

New Fourth Edition

TRAINS, TRACKS and TRAVEL



By T. W. VAN METRE

Professor of Transportation, Columbia University

A new edition of this popular elementary book on railroading is just off the press. It has been thoroughly revised and obsolete illustrations have been replaced to show latest equipment. There is a new chapter on streamlined trains and additions to others cover recent developments in air conditioning, air brakes and Diesel and electric locomotives.

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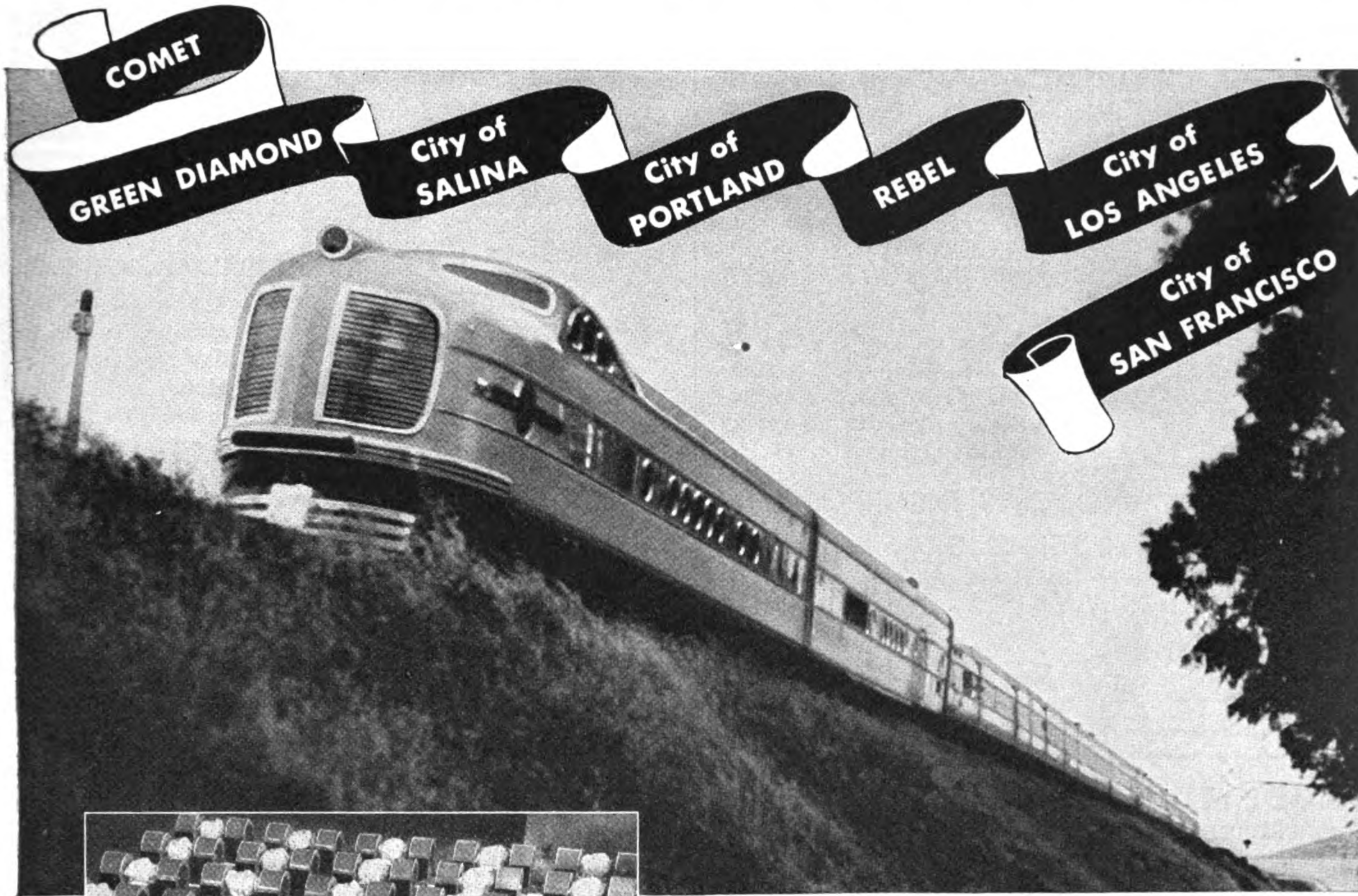
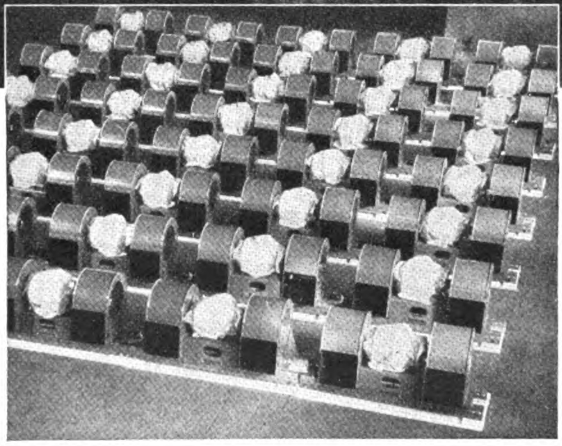
7 RECENT *Streamlined* TRAINS





Part of a large shipment of Sturtevant air circulating units to be used for air conditioned cars.

Equipped with Sturtevant Fans for air conditioning and engine cooling

Over 6000 passenger cars on 37 railroads are now equipped with Sturtevant Railvane Air Conditioning Units or Systems. Many of these cars are also equipped with Sturtevant Railvane Air Distributing Systems.

Railvane Air Conditioning is protected by 25 basic issued patents and other patents pending.

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are now used by 37 railroads. Railvane Air Conditioning is protected by 25 basic issued patents and other patents pending.

FOR 25 YEARS...PIONEERS IN AIR CONDITIONING

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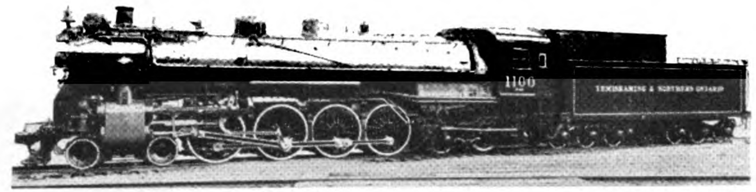
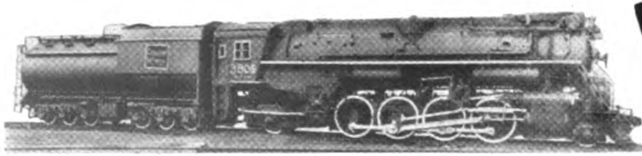


BARCO equipped Temiskaning and Northern Locomotive 1100.



BARCO equipped Canadian National Locomotive 3805.

BARCO equipped Canadian National Locomotive 6162.

The locomotives shown here were built this year for Canadian Railroads. They are equipped with BARCO power reverse gears, BARCO Metallic Connections between locomotive and tender, BARCO Joints in locomotive piping, and BARCO rear of tender connection. Such recognition is proof that the use of BARCO equipment by leading railroads depends on value and service. BARCO is first choice because of safe, reliable performance at lower cost.

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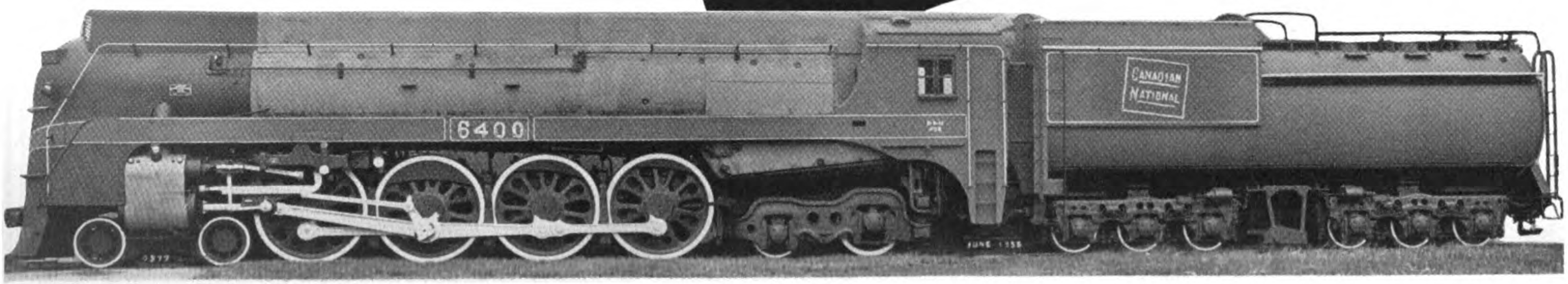
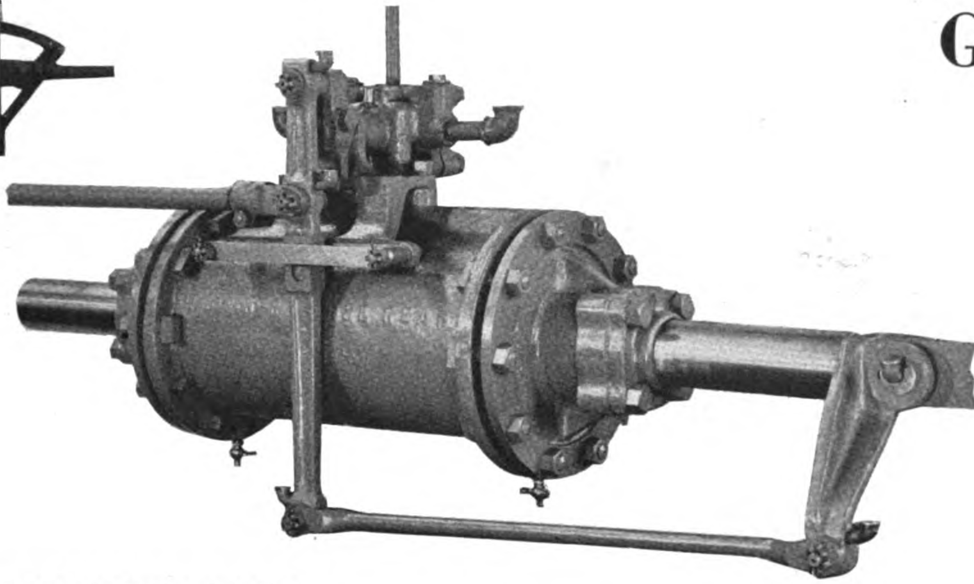
BARCO equipped Canadian Pacific Locomotive 3001.

BARCO equipped Canadian National Locomotive 6400.



Here is your BALDWIN POWER REVERSE GEAR



TRUNK TYPE GEAR
(Type "T")
as illustrated above has hollow extended piston rod—no guides or crosshead.

CROSSHEAD GEAR
(Type "C")
with conventional guides and cross-head can be supplied if desired.

Improved features, proper design and precision methods of manufacture insure dependability in operation and low maintenance costs.

Backed by more than 50 years experience gained since the first Baldwin power reverse gear was patented in 1882.

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Valve and seat of non-corrosive alloy can be removed for regrinding at the bench. Spare valve and seat can be quickly applied, preventing costly detention in shops.

THE BALDWIN LOCOMOTIVE WORKS
Philadelphia, Pa.

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DECEMBER, 1936

Railway Mechanical Engineer

FOUNDED IN 1832

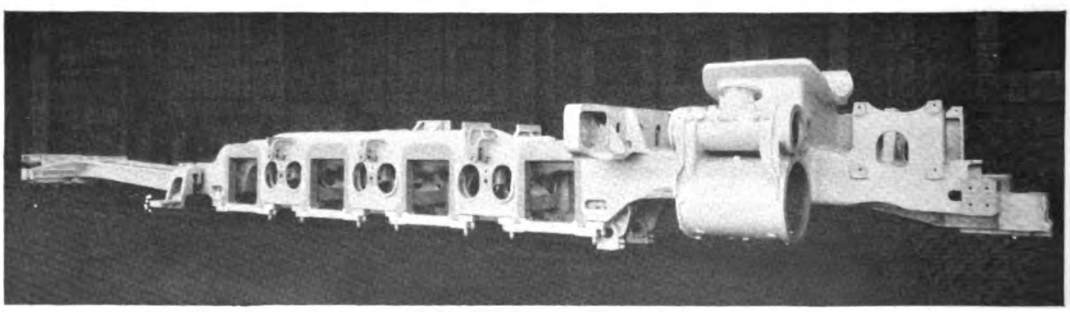
December, 1936

The Foundation of Economical Performance

COMMONWEALTH ONE-PIECE CAST STEEL LOCOMOTIVE BEDS are recognized to be essential to the economical performance of modern power.

The rigid unit design not only eliminates the problems and expensive maintenance of built up frames but also contributes to the longer service life and lower repair costs of many moving parts.

COMMONWEALTH Products on the above modern 4-8-4 locomotive include Boxpok Driving Wheels, Engine Truck, Delta Trailer Truck, Six Wheel Tender Trucks, Waterbottom Tender Frame and one-piece Cast Steel Bed.



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VOL. 110 No. 12

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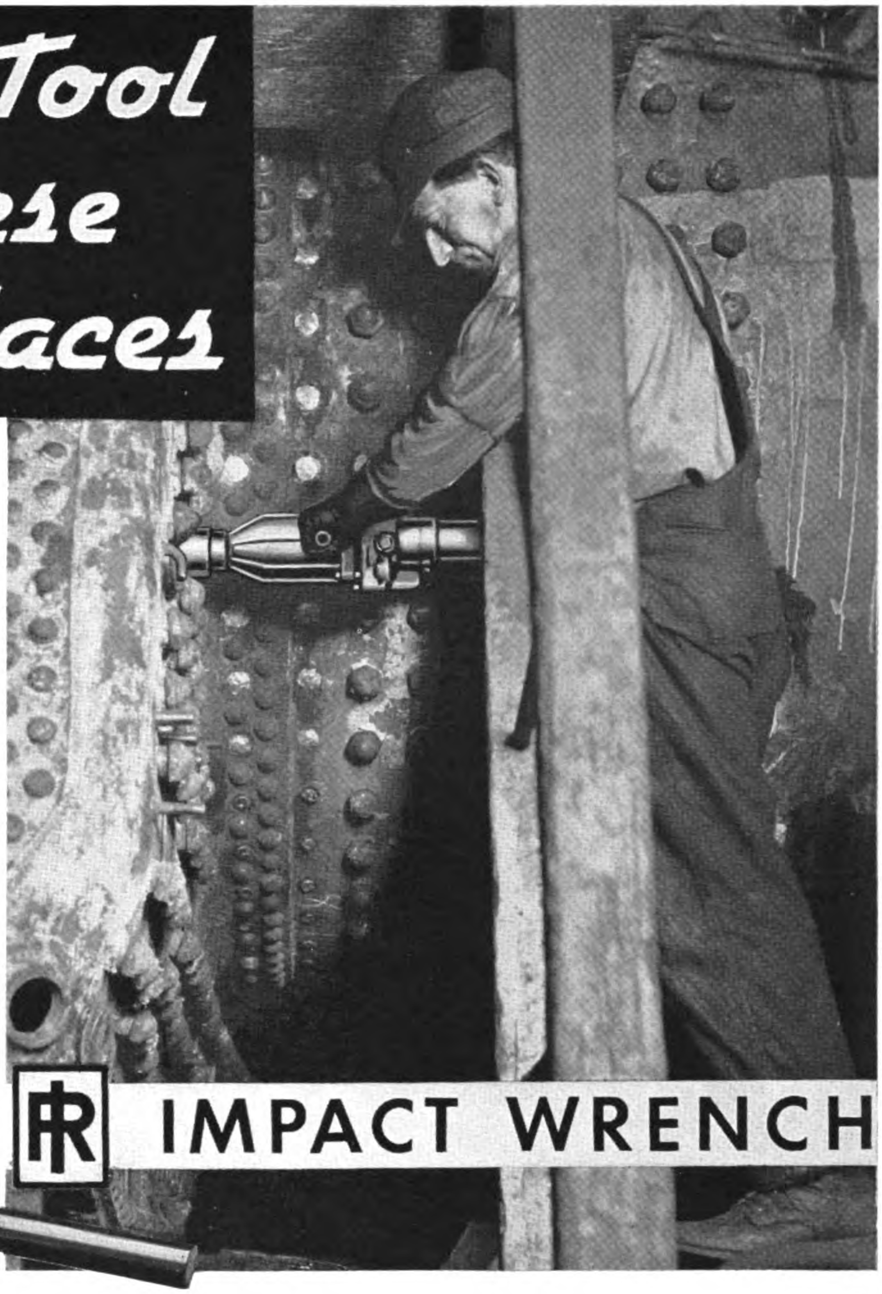
A Great Tool for these Tight Places



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THE I-R Impact Wrench removes tough staybolt caps in hard-to-get-at throat sheets with perfect ease. Just place this light-weight wrench on the cap. Press the trigger—and instantly the cap is removed. Similarly all frozen caps and corroded bolts that other wrenches cannot budge are easily loosened with this outstanding pneumatic wrench.

Recent installations have demonstrated that I-R Impact Wrenches pay for themselves in 30 days in back shops and in 8 months in engine houses. They save their cost many times over. That's why you cannot afford to be without them. A five minute's demonstration will prove our claims for this greatest of pneumatic tools.

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